

A. R. P.

by

J. B. S. HALDANE, F.R.S.

SEPTEMBER: A.R.P. by Professor J. B. S. Haldane. Little description is necessary. It is clear that a comprehensive book on Air Raid Precautions by this author, distributed to our membership and lent by them to their friends, will have profound political significance. The book can be easily readable by everyone, any difficult technical matters being put in the Appendix.

LONDON

VICTOR GOLLANCZ LTD

1938

BY THE SAME AUTHOR:

SCIENTIFIC BOOKS

ENZYMES

THE CAUSES OF EVOLUTION

POPULAR BOOKS

DAEDALUS, OR SCIENCE AND THE
FUTURE

CALLINICUS, A DEFENCE OF
CHEMICAL WARFARE

ANIMAL BIOLOGY (WITH
J. S. HUXLEY)

POSSIBLE WORLDS

THE INEQUALITY OF MAN

FACT AND FAITH

HEREDITY AND POLITICS

FOR CHILDREN

MY FRIEND MR. LEAKEY

PRINTED IN GREAT BRITAIN BY PURNELL AND SONS, LTD. (T.U.)
PAULTON (SOMERSET) AND LONDON

Dedicated to
those who have asked me awkward
questions at public meetings on
Air Raid Precautions

PREFACE

THIS BOOK IS intended for the ordinary citizen, the sort of man and woman who is going to be killed if Britain is raided again from the air. I believe that you, readers, can enormously reduce your own risk of being killed and the risk of your children being killed if you demand the necessary protective measures. I have seen the results of air raids during the present year, and I feel that I should be guilty of innocent blood if I did not make every effort in my power to save the people of Britain from the fate which is now befalling the peoples of Spain and China.

So much has been written on the subject of air-raid protection that many people will think that there is no need for another book. I do not agree. Most of the books and pamphlets on the subject seem to me to be of the nature of propaganda rather than truth. The Government and its supporters try to persuade us that we have only to follow the official instructions to be safe. I believe that this is untrue. But a great many opponents of the Government state that such things as gas-masks and gas-proof rooms are completely useless, that London could be wiped out in a single air raid, and so on. I believe that this is equally false. Even though I am convinced that the Government measures, as a whole, are inadequate, I shall give them credit for what they have done to protect us.

I shall not please those readers who take the view that the present Government can be trusted to do all that is necessary; nor yet those who think that it can do nothing right. For I believe that the matter is too important to allow my political views to interfere in any way with a strict adherence to truth. I have seen children killed in air raids, and I think that a frightful responsibility rests on those who expose British children to such a death in order to score a point for or against Mr. Chamberlain. So those who have bought this book merely as a source of political propaganda and not with a view to saving their lives and the lives of their fellow-citizens need read no further.

As I am attacking the views of experts, both on the side of the Government and against it, I must be excused if I state my own qualifications. From 1905 to 1922 I was associated with the work of my late father, J. S. Haldane, C.H., F.R.S. This research was concerned with the ventilation of mines, factories, schools and ships, and with the effects of various gases on the men who breathed them. For this work J. S. Haldane was made President of the Institution of Mining Engineers, and received numerous other British and foreign honours. In 1915 J. S. Haldane was sent over to France to devise measures of protection for the British army against German gas attacks. I was at that time a captain in a British infantry battalion and was brought out of the trenches to St. Omer, where I assisted my father in the design of some of the first gas masks.

Apart from this, I have published at least a dozen scientific papers describing research on the physiology

of breathing. I have a certain acquaintance with explosives, having commanded a bombing school for a year in 1915-1916, and as I was wounded in 1917 by an aerial bomb, I can claim a first-hand acquaintance with these weapons. In 1924 I was appointed a member of a Cabinet Committee on aerial defence, and served on it for some years, under the first Labour Government and the Conservative Government which succeeded it. This is as a matter of fact a slight handicap, as the Official Secrets Act forbids me to mention certain topics discussed by this committee. But it permits me to speak with a certain degree of authority. In the years 1936 to 1938 I spent nearly three months in Republican Spain, and was present during a number of air raids. As a result of this experience I largely modified my former views as to the relative danger from incendiary and explosive bombs, and as to the possibilities of defence from them.

Before my last visit to Spain, which was made in order to study air raid precautions there, I was asked by an official of the Foreign Office whether I would put the information gained at the disposal of the British Government. I said that I would be very glad to do so; but although I returned in January 1938 the Government has not asked me any questions on the matter. As I believe that the lessons of the Spanish war are quite literally matters of life and death to the British public, I have no option but to write this book. I have however been appointed a member of a committee of the Labour Party on Air Raid Protection, and hope also to be able to do something of value through Parliamentary channels. But I am absolutely

convinced that nothing short of a great national movement on non-party lines will force the Government to protect the people from the real and terrible danger which awaits them.

I shall do my very best to make this book intelligible to every reader. But one real difficulty must be faced. Many of the questions which are asked concerning Air Raid Precautions are unanswerable in the form in which they are put. If I am asked "Does any gas mask give complete protection against phosgene" the only literally true answer is "No." One could not live in a room full of pure phosgene in any of them. And one would be killed if a hundred-pound phosgene bomb burst in the room, even when wearing the very best mask. But one would be safe in a phosgene concentration of one part per thousand, of which a single breath would probably kill an unprotected man. Hence in practice such a mask is a very nearly complete protection.

It is the same with shelters. There are bombing 'planes which can carry four tons, and if one of these concentrated all its effort on carrying a single four-ton bomb, and aimed exactly right, it would no doubt destroy a shelter which was safe against bombs weighing one ton. Nevertheless I shall call a shelter bomb-proof if it will stand up to a one-ton bomb.

It follows that the answer to almost every question must involve numbers. I have tried to banish the most technical parts of my argument into Appendices. But I hope that even these are readable. Nevertheless the main argument can be followed without them.

A further difficulty has just arisen. In the debate which took place in the House of Commons on June

1st, 1938, Sir Samuel Hoare made a number of statements completely reversing the policy laid down in the official documents, particularly as regards evacuation and the medical services. I have tried to revise the book accordingly, but I may well have missed some points in his speech. It is quite probable that in the time which elapses between the writing and printing of this book there will be further changes in official policy.

I have also added footnotes regarding official answers given on June 15th, 1938, to questions relating to several points of detail which I had raised at meetings of the Labour Party's A.R.P. committee. Readers will be able to judge for themselves whether the questions have been answered or evaded.

I cannot close this preface without two remarks. I hate having to write this book. Air raids are not only wrong. They are loathsome and disgusting. If you had ever seen a child smashed by a bomb into something like a mixture of dirty rags and cat's meat you would realize this fact as intensely as I do. And I sympathize with the attitude of those who feel that the whole business is so horrible that they will have nothing to do with it.

But I do not share this attitude. Few or none of those who hold it would refuse to rescue an injured child during an air raid. I hope to convince them that if they take a purely negative attitude at present they will be endangering the lives of others should a war come.

Above all I hope, in spite of the terrible international situation, that this book will prove unnecessary, and that the people of Britain will never see what I have seen in Spain.

that
It h
respe
Coun
gistr

App

C

or T

Class

Fin

gain

on

y th

y th

C

ub-J

the

dge

ter

urt

stati

itici

Just

rties

icial

ch o

vas

tativ

ts.

es fr

up

fy hi

over

CONTENTS

Preface	<i>Page</i> 7
<i>Chapter</i> I. The Technique of Mass Murder	15
II. The History of Air Bombing	41
III. Keeping Bombers Away	66
IV. The Government's Precautionary Measures	77
V. Further Government Schemes	113
VI. Protection Against High Explosive Bombs	143
VII. Evacuation	182
VIII. An A.R.P. Scheme Giving Complete Protection	201
IX. The Political Aspect of A.R.P.	222
X. Summary	251

CONTENTS

APPENDICES

<i>Appendix I.</i> Poisonous Gases and Smokes	<i>Page</i> 255
II. Gas-masks, and Gas-proof Bags for Babies	263
III. Calculations Regarding Leakage into and out of Rooms	269
IV. Gas-proof Boxes	272
Bibliography	277
V. Recent Developments	282
Index	294

LIBRARY OF
EWING CHRISTIAN COLLEGE
ALLAHABAD

CHAPTER I

THE TECHNIQUE OF MASS MURDER

SHAKESPEARE WAS ONE of the few people who have ever lived who could see more than an inch in front of their noses. His opinions on aerial warfare are therefore worth reading.

“Could great men thunder
As Jove himself does, Jove would ne’er be quiet,
For every pelting, petty officer
Would use his heaven for thunder;
Nothing but thunder. . . .”

said Isabella.¹ It is worth contrasting this with the shallow optimism with which lesser writers greeted the invention of the aeroplane. In Shakespeare’s own time the development of the sailing ship was playing a big part in breaking up the old mediaeval civilization, and beginning the epoch of imperialist expansion. The seas were full then, as the air is now, of pirates covertly supported by lawful Governments. The London taverns swarmed with “pelting, petty officers” whom three hundred and fifty years later we romanticize as bluff Elizabethan sea-dogs.

We do not know Jove’s opinion on aerial bombardments. But the ordinary human being finds them horrible. However, indignation is singularly useless unless it is directed by knowledge. So the first essential if we are to judge of the possibilities of countering them,

¹ *Measure for Measure*, Act 2, Scene 2.

is to study their technical side with as little emotion as possible.

An enemy airman can use four different weapons against civilians, namely, machine-guns, gas, incendiary bombs, and explosive bombs. He can also launch torpedoes against ships.

MACHINE-GUNS

Every military aeroplane is armed with several machine-guns whose main use is for fighting other 'planes in the air. The light fighting aeroplanes, which can manœuvre more quickly than the heavier bombers, are particularly suited for killing people on the ground in this way. In order to hit people on the ground the 'plane must fly very low, not much more than fifty feet above ground level. So this form of attack is not very dangerous where there are tall buildings or trees. A bullet is a piece of metal about one or two inches long, and as thick as a thin pencil. A machine-gun can fire 10 or 12 bullets per second, so if it is flying above a road at 200 miles per hour it will fire a bullet once in every ten yards or so. As however these bullets come down at a gentle slope, and not vertically, this is more dangerous than it sounds.

A bullet will not penetrate an ordinary brick wall, so people in a house are almost safe. But bullets are very effective against people crowded on a road. At Guernica the German aeroplanes first bombed the town so as to drive the people out into the country, then attacked them with machine-guns to drive them back again, and so on. A column of motor vehicles on

a road is very vulnerable to this type of attack. This fact seems to have been forgotten by various writers who have proposed that on the outbreak of war private car-owners should flee into the country with their cars loaded with refugees.

A few wrecked or even abandoned motor vehicles will effectively block even a broad road. And a traffic jam is a good target not only for machine-guns, but for light bombs. I would far rather be in central London during a big air raid than in a traffic jam on the Barnet Bye-Pass or the Great West Road.

On the other hand, if the main roads out of our cities were closed to private cars and reserved for columns of motor omnibuses fifty yards or so apart, protected by British fighting 'planes, evacuation would be comparatively safe. In 1916-1918 wealthy car-owners slept at Maidenhead and other relatively safe places, and came into London during the day. In a future war this sort of thing should be strictly forbidden, at least until the evacuation of women, children, and aged civilians has been absolutely completed.

BRITISH ANTI-AIRCRAFT SHELLS

When a shell from an anti-aircraft gun bursts, it forms a number of splinters, and also sends out round shrapnel bullets. These fall to the ground with great speed, and can easily kill a man, though a steel helmet gives a good deal of protection. They killed a number of Londoners in 1916-1918. In some raids they caused as many casualties as the enemy bombs. Even a badly

built house gives fairly complete protection against these splinters, as against machine-gun bullets. And for both these reasons it is desirable to stay indoors during an air raid.

GAS AND SMOKE

A brief technical account of the most dangerous kinds of gas is given in Appendix I. They are as follows:—

1. NON-PERSISTENT GASES, such as phosgene. They can be dropped in bombs which burst, and suddenly let loose a cloud of gas, which is poisonous when breathed, but which gradually disperses. If there is a wind the dispersal is very quick; in calm, and especially in foggy weather, it is much slower. These gases can penetrate into houses, but very slowly. So even in a badly-constructed house one is enormously safer than in the open air. Even the cheapest type of gas mask, *provided it fits properly and is put on at once*, gives good protection against them (see Chapter IV).

2. PERSISTENT GASES, such as mustard gas. Mustard gas is the vapour of an oily liquid, which I shall call mustard liquid. So far as I know this has not been dropped from aeroplanes in bombs on any great scale. It was used very effectively by the Italians in Abyssinia, who sprayed it in a sort of rain from special sprayers attached to the wings of low-flying aeroplanes.

Mustard gas not only attacks the lungs and eyes, but the skin, on which it raises blisters. A respirator will protect the eyes and lungs, but not the skin.

However, the skin burns, if properly treated, are never fatal and rarely disfiguring. It is particularly dangerous for another reason. Other gases affect the eyes, nose or throat very quickly, and thus give an unmistakable warning that they are dangerous. Mustard gas gives no warning save a quite faint smell of mustard; and the bad effects rarely begin for two hours, and sometimes not for two days.

A drop of mustard liquid on the skin will almost certainly cause a burn if it is not removed within two minutes with water or petrol. The vapour from a drop on ordinary clothes will penetrate in about five minutes. It will soak through leather boots in about half an hour.

If the liquid is splashed over the ground it evaporates slowly, and some may remain for days or even weeks. On the other hand the gas concentration in the open is rarely very strong, and exposure to the vapour for a minute or so will probably not hurt a man even without a respirator. The danger arises from the persistence of the gas over many hours, which causes chronic poisoning.

3. POISONOUS SMOKES. Some compounds of arsenic, when heated, form a very fine smoke, which causes great pain when breathed, and usually produces sneezing. This is never fatal, but the sneezing may be so severe that a respirator cannot be worn. Further it will penetrate certain respirators which are gas-proof.

Gas and smoke proved fairly effective in the 1914-1918 war. They caused nearly 200,000 casualties in the British Army alone. During the war they were discharged from cylinders on the ground, from shells,

and also from drums shot for a few hundred yards from trench mortars. How will they be used in air raids?

HOW AEROPLANES WILL DROP GAS

An aeroplane can drop gas in two different ways. It can drop a bomb full of a liquefied gas or of a solid which goes up in smoke when heated. Or it can spray mustard liquid from special apparatus on the wings. Suppose a one-ton bomb contains three-quarters of a ton of liquid phosgene. This takes up 6,000 cubic feet when transformed into gas. But one part of phosgene in 20,000 of air will kill a man in five minutes. So a one-ton bomb will poison 120 million cubic feet of air, for example a layer twelve feet high and covering nearly half a square mile. Of course, in practice the concentration would be greater in some places and less in others, and as the gas would rise higher than twelve feet in some places the area of serious danger at any given time would be less than half a square mile. Nevertheless twenty large bombers carrying two or three tons of bombs apiece could render the outside air of a good part of central London, or most of Sheffield, poisonous, so that no one could go out of doors without a gas mask.

If there were any appreciable breeze most of this gas would be blown away in an hour or so, though the drifting gas-cloud might still be dangerous ten miles or more away.

If the same amount of mustard liquid were dropped in bombs the effect would probably be less serious. For the liquid would be concentrated over certain

quite small areas, say 3,000 of them, if twenty bombers dropped 150 twenty-pound bombs each, and all the bombs burst. In this case if the air-raid wardens were efficient, almost everyone could quickly be moved into a gas-free area.

If the mustard liquid could be sprayed evenly, things would be far more serious. All the outside air of a large town would be poisonous for several days. But this would only be possible if the spraying aeroplanes could fly to and fro over the town in formation, and at a height of not more than 300 feet or so. A fine rain of mustard liquid would probably evaporate on its way to the ground, or blow away, if it were let loose several thousand feet up in the air. Spraying from low-flying aeroplanes was possible in Abyssinia because the Abyssinians had no anti-aircraft guns and no defensive aeroplanes. It would probably not be possible in Britain.

Bombs liberating poisonous smokes would let loose an amount of smoke far less than the amount of gas liberated by gas bombs. For it is necessary to heat the chemical which liberates the smoke. This needs a special device which must be solid enough to stand the shock of landing. So a large part of the weight of a smoke bomb must consist of metal, and from the killer's point of view, this metal is wasted.

THE HAMBURG DISASTER. Fantastic nonsense has been talked about the possible effects of gas bombs on a town. For example, Lord Halsbury said that a single gas bomb dropped in Piccadilly Circus would kill everyone between the Thames and Regent's Park. Fortunately, although no gas bombs have been dropped

in towns in war-time, there are recorded facts¹ which give us an idea of what their effect would be. On Sunday, May 20th, 1928, at about 4.15 p.m., a tank containing 11 tons of phosgene burst in the dock area of Hamburg. The weather was warm, and there was a mild, north-easterly breeze. The gas-cloud passed mainly over open spaces, but it also passed through the suburb of Nieder-Georgswerder. There was no warning. Most of the victims were out-of-doors, playing football, rowing, or even going to vote in an election. The windows were open, so a few people were killed indoors, at least one on the first floor.

Casualties occurred up to six miles away. In all 300 people were made ill enough to be taken to hospital, and of these ten died. About fifty of the rest were seriously ill. These casualties are remarkably small. They would have been much greater had a southerly breeze taken the cloud into the main part of Hamburg. But they would probably have been nil had the people received ten minutes' warning, so that they could have got into houses and shut the windows.

No doubt enemy aeroplanes would have dropped the gas in a more thickly populated area. But they would not have taken people by surprise, and the casualties would probably have been about the same, perhaps less if they had gas masks. Eleven tons of gas could be carried in about fifteen tons of bombs. Now fifteen tons of high explosive bombs would cause 600 casualties on the basis of the figures for England, in 1917-1918, and considerably more, probably 1,500,

¹ Hegler, *Deutsche Medizinische Wochenschrift*, 1928, p. 1551.

on the average for Barcelona in 1938. Of these casualties not one in thirty, but one in two or three, die, and many of the rest are permanently mutilated. Besides this, buildings are destroyed, and roads blocked. On this estimate the explosive bomb is very considerably (perhaps fifty times) more deadly than the gas bomb.

It is sometimes objected that the Hamburg explosion occurred in the summer, and that gas clouds liberated in summer are ineffective. It is true that in winter they stick more closely to the ground. On the other hand windows are shut. And a critic at a meeting informed me that the Hamburg cloud "must have" gone straight up into the air. In spite of which it injured people on the ground six miles away. Even if we granted that the killing effect would have been five times as great in winter, which I personally doubt, the effect would still have been much less than that of high explosives.

WHY GAS WAS NOT USED IN SPAIN

In view of the terrible stories as to the effects of gas, many people are surprised that it has not been used in Spain. First, why was it not used against the loyalist army? Secondly, why was it not used against towns? The soldiers had respirators after about February 1937, but were not well trained in their use, and often lost them. Very few civilians had any respirators at all.

Gas was not used in the field for several reasons. The main reason is that the number of men and guns per mile was far less than on the fronts in the Great War. Gas is effective if you have a great deal of it,

but the amount needed is enormous. Thus during the night of March 10-11th, 1918, the Germans fired about 150,000 mustard-gas shells into an area of some twenty square miles south-west of Cambrai. If most of the air in a large area is poisoned the effects are serious. But if a few gas shells are fired or a few cylinders let off, the gas soon scatters and ceases to be poisonous, and a man can often run to a gas-free place, even without a mask, before he is poisoned.

Gas was not used against the towns for this reason, and for another, which is very important. Gas only leaks quite slowly into houses, particularly if there are no fires to make a draught, and draw in outside air; and there is very little fuel in loyal Spain. It is difficult to give exact figures. But I think it is certain that at least ten times as much gas is needed to poison people in houses as to poison them out-of-doors. Further, in the large Spanish towns most of the houses are tall, and very little gas indeed would reach the third or fourth floor of a house.

Nevertheless a good many people would have been killed by a gas raid on a large town. *Such raids were not carried out for a perfectly simple reason. A great many more people can be killed by a given weight of high explosive bombs than by the same weight of gas bombs.* Franco's friends in England say that he does not use gas for humanitarian reasons. Anyone who has seen even a few children killed by high explosive bombs will dismiss this statement as nonsense.

If then gas was not used against the Spanish towns where the civilians had no respirators, I believe that it will not be used on any great scale against British

towns, particularly after the promised supply of respirators becomes available for British civilians.

This is not to say that it will not be used at all. It is not unlikely that a few gas attacks may be made for several reasons. Mustard liquid may be dropped on certain key areas so as to disorganize transport or production for several days on end. It may be hoped that a panic will be produced. And it may be desired to confuse the British defensive effort by making a certain amount of anti-gas measures necessary. It is much easier to defend yourself against explosive bombs alone than against explosives and gas.

INCENDIARY BOMBS

These bombs usually contain thermite, which is a mixture of 23 per cent of aluminium powder with 77 per cent of iron oxide (Fe_2O_3). Other mixtures are said to have been used, for example one containing calcium; and the bomb may be made of magnesium, so that it burns. When such a mixture is heated, the aluminium unites with the oxygen of the iron oxide, and a mixture of alumina slag and white-hot molten iron is produced. This throws out some sparks, but the main effect is downwards. The molten iron penetrates wood, or even thin metal, like so much butter, and sets light to anything inflammable which it touches. Thermite is used in industry for welding.

There are other types of incendiary bomb, for example the phosphorus bomb, which throws burning fragments for some distance, and generates a great deal of smoke. But though it is more alarming, and

more likely to burn people who try to put it out, it has no penetrating power, and the heat is not so great at the centre.

These bombs may weigh from about 2 to 50 lbs. So a bombing aeroplane can carry a thousand or more of the smallest type, and scatter them over a town. About one tenth of central London is covered by houses, and if one bomb in three which hits a house sets it alight, a single aeroplane might start thirty or fifty different fires, and a squadron could cause over a thousand at once, which would be more than the fire brigades could deal with.

Such is the theory, and before 1936 it appeared reasonable. I have stated in print that the incendiary bomb was as great a danger to London as the explosive bomb. The German Air Force authorities also seem to have held this theory. But it was wrong. Like a great many other theories, it did not work in practice.

In the early aerial bombardments of Madrid in 1936 a great many incendiary bombs were used. But they were vastly less effective than was expected. The total number of buildings destroyed by them was twenty-three,¹ whereas many hundreds were destroyed by explosive bombs. After the middle of December 1936 no more incendiary bombs were used on Madrid, and they were not used on any great scale against Barcelona, Valencia, or Sagunto, though a few heavy ones weighing 30-50 lbs. were used on Barcelona in

¹ I am not absolutely certain of this figure, which was that given at an exhibition relating to Madrid, and held in Barcelona in December 1937. As a foreigner in a city under bombardment, and infested with spies, I did not consider it healthy to take too many notes. I am, however, completely certain that the number officially given was under thirty.

the spring of 1938. They were used fairly effectively on Guernica. But Guernica is a special case of a small town with no real defence raided continuously for many hours (see p. 50). So long as a British Air Force exists this can hardly happen in Britain.

I do not know the reasons for their failure. A good many did not light. Thermite is not very easy to ignite, and it may be that the ignition mechanism was smashed by the fall. It is also possible that on the whole less wood is used in Spanish than in British houses. But the average Spanish house certainly has wooden floors (except for the ground floor) and rafters. It may be added that they would be very effective against wooden houses, which are common in many parts of the U.S.A., China, Japan, and the U.S.S.R.

Whatever may be the reason, incendiary bombs are far less dangerous to British towns than high explosive bombs. These latter constitute the main danger against which we ought to guard.

HIGH EXPLOSIVE BOMBS

These bombs weigh anything from about ten pounds up to one ton, though bombs weighing $1\frac{1}{2}$ and 2 tons are said to be in existence. In the ordinary bomb anything from one-quarter to one-half the weight consists of explosive. For it need only be a thin metal case full of explosive. It does not have to stand any shock till it actually hits the ground. On the other hand a shell has to be very solidly made to stand the shock of firing from a gun. If it bursts prematurely it may kill the gun's crew. Whereas a bomb which breaks up

on hitting the ground at worst fails to explode. So a 15-lb. shell may contain less than 2 lbs. of explosive. Thus, an aerial bomb is commonly about five times as destructive as a shell of the same weight.

There are, however, two kinds of bomb which contain a larger proportion of metal. One is the armour-piercing bomb, which is made of solid steel, and is intended for use against ships and forts. The other is the small fragmentation bomb, intended to give the maximum amount of splinters when bursting. This is used against soldiers in the open, crowds, and traffic.

A bomb may burst on impact, or have a delayed action. Clearly a fragmentation bomb must burst on impact. It is almost harmless if it buries itself in the ground before bursting. On the other hand an armour-piercing bomb must penetrate as far as possible before it bursts.

WHAT IS AN EXPLOSION?

In order to understand the effects of an explosion, it is necessary to explain what is meant by the word. An explosive is a solid which can be changed very suddenly into hot gas. The word gas is used in science for anything which has the same kind of physical properties as air, for example lighting gas in the gas pipes, water-vapour in the cylinder of a steam engine, or the burning vapours in a candle flame.

Now when a solid or liquid is changed into gas it expands a great deal. For example a cubic inch of water expands into a cubic foot of steam. And when the gases are very hot they occupy still more space. Thus a cubic inch of trinitrotoluene is turned into about

two or three cubic feet of hot gas when it explodes. The explosion is always due to a chemical change like the change in burning. A candle, or even a piece of inflammable cinema film, which burns far quicker, does not explode, because the oxygen of the air cannot get quickly enough to the combustible material. But in an explosive the oxygen atoms are packed in a solid form very close to the carbon and hydrogen atoms with which they later unite. So a piece of explosive as big as a candle can generate nearly as much heat, and make nearly as much hot gas, as the candle, in less than a thousandth of a second, instead of several hours.

Now when a lot of gas is made from a solid or liquid, other things must make room. According to the rate at which the gas is formed the results are very different. The water in a boiler takes some hours to form steam, and the steam can be used to work an engine, though if the vent is blocked, it will burst the boiler. The mixture of air and petrol vapour in the cylinder of a car or bus motor explodes much quicker, but still it is able to use almost all its force in moving the piston, and does not burst the cylinder.

A mild explosive like gunpowder or cordite in a gun explodes in a small fraction of a second. But while it is exploding the bullet or shell can move away, so that most of its energy is used in moving the bullet.

But a high explosive goes off almost instantaneously, and everything round it must give way. If one put high explosive in the cartridge of a gun, the gun would be smashed to pieces, because, before the bullet had begun to move, the explosive would have been converted into a gas squeezed into less than one five-

thousandth of its normal volume, and exerting a terrific pressure. So a bomb exerts its destructive action almost equally in every direction.

The high explosives, such as trinitrotoluene, which are used in bombs, do not explode easily. Neither a violent blow nor a flame will cause them to explode. The explosion must be started by a detonator, which is a metal tube containing a small amount of a more sensitive explosive, such as mercury fulminate or lead azide, which is set off by a blow or a spark. The bomb may be so designed that it explodes immediately on hitting the ground or a house. Or the explosion may be delayed for two or three seconds, or longer. In this case the bomb does not explode till it has either buried itself in the earth or fallen through several floors of a building.

The damage done by a bomb is due to splinters, blast, shock, or a combination of them.

SPLINTERS. When a bomb bursts its metal case breaks up into splinters ranging from the size of a wheat grain up to several inches across. These fly at a great speed and may kill a man several hundred yards away, though of course the danger is much greater in the immediate neighbourhood. Besides these metal splinters, fragments of stone or brick fly about if the bomb bursts in a house or on a paved street. The splinters are generally of an irregular shape and make much larger wounds than a rifle or machine-gun bullet of the same size. Some will go through a 6-inch brick wall such as that of an ordinary small house. Very few will go through a $13\frac{1}{2}$ -inch brick wall.

The danger is greatest from a bomb which bursts immediately on hitting the ground. In this case many

splinters fly out sideways, and cause appalling casualties in a crowded street. If the burst is delayed the bomb often buries itself in the ground, and most of the splinters fly upwards. So bombs which burst immediately are used in attacks on roads covered with traffic, and in surprise attacks on towns where the people have not had time to get indoors.

, BLAST. The hot gases from a bomb not only burst its case but push away everything in the neighbourhood, with an almost inconceivable force. The air in front of them is pushed forward at a speed of about four thousand miles an hour, twenty or more times the speed of the most rapid hurricane. A man standing within ten yards of a large bomb will be torn to pieces, and the pieces thrown for hundreds of yards. A brick wall is not merely knocked down. It is shattered into a hail of projectiles which may kill people at a great distance.

At a still greater distance the blast is translated into a wave of sound, but a sound like that of the last trumpet which literally flattens out everything in front of it. Remember the loudest thunder-clap that you have ever heard. You would not notice it in the middle of an artillery barrage. But an artillery barrage is nothing to the explosion of a big bomb; and dozens may explode at once.

It is the last sound which many people ever hear, even if they are not killed, because their ear-drums are burst in and they are deafened for life. It occasionally kills people outright without any obvious wound. I was running towards a medium-sized bomb when it burst. My mouth was open, and the shock was so

violent that I was unable to breathe for some seconds, and indeed thought that my throat had been torn away, and that I had only another half-minute or so to live. I did not notice that I had been wounded until I had felt that my throat was intact, and managed to start breathing again. It may well be that others have been killed by paralysis of the breathing, in similar cases, without any wounds at all. Nevertheless I am sceptical of the statements that people in Barcelona fell down dead without any wounds when a bomb burst 400 yards away. This only seems plausible in the case of people with very weak hearts.

The pressure wave, which only persists at any point for about one thousandth of a second, is succeeded by a pulse of negative pressure or suction, which appears to last a little longer. This is analogous to the hollow behind a big wave in water. It leads to paradoxical results. Thus when a bomb has burst in a Spanish street the metal shutters of shops which have not been knocked down are sucked outwards. And when a bomb falls inside a house, a large part of the shattered walls fall inwards.

The blast from a quarter-ton bomb will knock down an ordinary house at 25 yards. A one-ton bomb will do the same at 50 yards.¹ This is the case if it bursts on the ground. If it buries itself in soft ground most of the blast goes upwards. But a bomb falling in the middle of a street will probably knock over houses on both sides. And things are worst of all if it falls in a

¹ I do not believe the statement in the *Daily Express* of March 19th, 1938, that a luxury hotel was blown in by the blast of such a bomb 100 yards away. It may be true, but I prefer to stick to well ascertained facts.

place surrounded by buildings, such as a court or yard. During the 1914-1918 war only one bomb weighing much over a quarter of a ton¹ was dropped on London. This destroyed four houses at Warrington Crescent, Paddington, and damaged hundreds, though the damage was usually small (e.g. falls of plaster).

These statements apply to the average brick house. Where very solid stone is used the houses are harder to knock down. Very little damage was done by the Zeppelin bombs which fell on the "Old Town" of Edinburgh in 1916. But it must be remembered that houses with impressive-looking stone fronts in London and other English cities are often built of brick or poor quality stone inside.

However, a building may be wrecked by blast even if its walls stand. For example a large bomb burst near a hospital at Tarancon in Spain about Christmas 1937. The walls did not fall, but the blast entered the windows and lifted the floors up. They fell down again, crushing fourteen wounded men to death, and leaving the building a mere shell.

Ferro-concrete buildings, or indeed any buildings with a steel frame, are far harder to destroy. The blast from a bomb may be described as a gust of wind moving at several thousand miles an hour, but only lasting for a small fraction of a second. Under such a shock the frame building bends, but is not smashed, even though it is permanently bent.

¹ Pierce gives the weight at 660-2,000 lbs., probably 660, Hyde and Nuttall at 2,000. This illustrates the great difficulty of getting at facts. I am inclined to trust Pierce, as Hyde and Nuttall are occasionally wrong where I can check them. For example, they state that gas has been used by both sides in Spain.

Finally, blast may break windows up to a quarter of a mile or so away. This is more serious than it sounds, since it allows gas to enter houses.

SHOCK. The explosion produces a wave of pressure in earth or other solids, just as it does in air. The deeper it has gone into the ground before it bursts, the bigger the shock and the smaller the blast effect. The earth immediately around the bomb is blown up into the air, and a good deal more is pushed down or sideways, forming a crater. The largest crater in Barcelona, probably from a half-ton bomb, is said to be 22 feet deep and 60-70 feet across. However, this is quite exceptional. A crater over 30 feet across is unusual. Of course everything on the site of the crater is completely wrecked.

Below and at the sides of the crater the shock wave travels through the ground, gradually diminishing in violence. Buildings near the crater are knocked over to some extent by shock as well as blast, and it is hard to distinguish their effects. However, a steel frame building stands up to bomb shock, as to earthquakes, better than a stone or brick building. The modern German practice in Spain is to send a fleet of 50 or 100 bombers over a town or village. These all drop their bombs at once, and the combined shock and blast of several hundred bombs subjects a whole village to the combined effect of an earthquake and a whirlwind, so that every building is shattered. There is one paradoxical fact about shock waves. They travel more easily through hard than soft material. This is a well-known fact for ordinary shocks. If you hold one end of a log against a man's head, and hit the other

with a hammer, you will injure him. But if, instead of a log, you have a cushion or even a bag of potatoes between two bits of wood, he will not be hurt.

If a large bomb goes off against a block of solid cement fifteen feet thick, it will probably smash right through it. But if, instead, there are two five-foot cement blocks with five feet of earth between them the first block will be smashed, but the layer of earth will break up the shock, and the second block of cement is likely to hold. As we shall see, this principle is important in making bomb-proof shelters.

PENETRATION. This word is used to designate the distance to which a bomb will carry destruction. It depends on the depth to which the bomb reaches before it explodes, on the violence of the shock, and on many other things. The depth in the earth, or the number of floors in a building through which a bomb will go before it bursts, is increased both by the weight of the bomb and the height from which it falls. It also depends on the shape of the bomb. We may take it that a large bomb dropped from 15,000 feet or more travels at a speed of at least 700 miles per hour or 1,000 feet per second.

A quarter-ton bomb will penetrate at least six floors of a building, even the cement floors of an ordinary ferro-concrete building, before bursting. If the building has not a steel frame it may be entirely wrecked. If it has a steel frame it will be badly damaged, but will probably not come down. A one-ton bomb will fall even further before bursting, and do more harm when it bursts. It must however be remembered that bombs never fall quite vertically. So it may enter a house through the wall as well as the roof.

The depth of penetration in the earth is another matter, and no definite figures can be given, for the following reason. A shock which would not crack a concrete vault would certainly bring down the roof of a tunnel with no support but pit-props. And a series of small vaults supported by thick pillars would stand where a broad roof with few pillars (e.g. Piccadilly Circus station in London) would give way. Again a cast-iron pipe would crack when a lead pipe would not. We shall take up this matter later in connection with underground shelters.

COMBINED ATTACKS

In Spain high explosive and incendiary bombs have been used together. In a night raid on a town a few large incendiary bombs may be useful, as once a fire is started it acts as a target for later raiders. Two simple principles can be laid down regarding gas attacks.

1. A gas attack will be more effective if it is made after an attack with high explosive bombs than if it is made before or simultaneously, providing the explosions have not started fires. For many windows will be broken, and houses which are not destroyed will be cracked. There will be rescue squads and perhaps panic-stricken people in the street.

2. Gas is not likely to be used with or at once after incendiary bombs. For a big fire makes an ascending current of air which sucks up all the poisonous gas in the neighbourhood and drives it into the upper air.

The blast of high explosive bombs would disperse gas, but this would not apply if the gas were dropped even five minutes after the explosive bombs.

PANIC

Panic can be a direct cause of death. If too many people crowd into a shelter, especially one with narrow stairs leading to it, they may easily be crushed to death. In January 1918 fourteen people were killed in this way at Bishopsgate Station in London, and sixty-six were killed in a panic in one of the Paris Underground stations as the result of a false gas alarm.

Possibly the indirect effects of panic are even more serious. If a hostile air force can once get the population of a town on the run, they can shoot them with machine-guns and attack them with light bombs which burst on hitting the ground and break up into innumerable splinters. A large fraction of the refugees from Malaga were massacred in this way in 1937.

And a panic is very hard to resist. Brave men who would certainly have held their ground if they had been alone, find themselves running if enough others start to run. For this reason anti-panic measures are of the greatest importance.

BACTERIA AND OTHER MICROBES

It is possible that these will be used in some kind of spray or dust. The difficulty is a technical one. It is easy to disperse many solids as smoke. But this needs heat, and cooked bacteria are harmless. Many

bacteria are killed even by drying. And once bacteria are on the ground they generally stay there. Possibly pneumonic plague or some other air-borne disease might be started by a dust-bomb. Cholera bacilli might be dropped in a reservoir. But they would probably be stopped by filters, and even without this would be likely to die before they reached the houses.

A million fleas weigh very little, and could easily be dropped. In theory they could be infected with plague. In practice this would need a staff of hundreds of trained bacteriologists, and huge laboratories. So with other possible means of infection. Some may very well be tried, if only to create a panic, but I would sooner face bacteria than bombs.

WILL THERE BE NEW TYPES OF GAS OR EXPLOSIVE?

A great many authors have given terrible pictures of future wars, where new types of explosive and gas are used. H. G. Wells has been a rather serious offender in this respect, painting terrible pictures of great cities wiped out in a single air raid, and wide areas poisoned for years on end.

We now know enough about the theory of chemical reactions to say that there is a definite limit to the amount of heat or other sorts of energy which a given weight of matter can yield. And we know that our existing high explosives are quite close to the upper limit. Actually there is no "better" high explosive for military purposes than trinitrotoluene (T.N.T.) which was discovered in 1879.

Of course if it is ever possible to gain complete control of changes in the nuclei of atoms such as cause radioactivity, much more formidable explosives will be possible. But at present we can neither speed these reactions up nor slow them down to the slightest extent, even in the laboratory, let alone in a bomb.

As for new gases, the possibilities are slightly greater, but not very serious, for the following reasons. There are plenty of substances which, per unit weight, are more poisonous than mustard gas; for example diphtheria toxin and the active substances in some snake venoms. But these are all substances with large molecules, much too large to form a gas or vapour. Only small molecules can do this. Now for over a century chemists have been making new organic compounds. And they have already made most of the possible types of small molecules. Mustard gas was discovered in 1886, and nothing worse had been produced by 1918. Lewisite is about as bad, but the Germans tried it and turned it down in favour of mustard gas. So, though it is possible, it is not very likely, that more effective poisonous gases will be invented.

Even if they are, it is fairly certain that they will be stopped pretty completely by the charcoal filter of a respirator. This stops all poisonous gases and vapours except those of low boiling point such as carbon monoxide. As these latter have very small molecules, it is reasonably sure that we can expect no surprises among them. So even if a new gas is produced, it is very unlikely that it will get through our respirators.

The danger from a new type of smoke is more

serious. The civilian respirator is much less efficient at stopping smokes than the service types. And even if it is good enough to deal with the smokes at present known (which many people doubt), it might fail against a more penetrating kind of smoke.

Nevertheless such a danger is rather remote. And efforts against it, though they should be made, are a vastly less urgent question than an attempt to combat the very real menace of the high explosive bomb.

KILLING POWER

Between January 1917 and November 1918 German aeroplanes dropped 71 tons of bombs on England. These killed 837 people and wounded 1,991. On March 16-19th, 1938, 41 tons of bombs were dropped on Barcelona by German and Italian aeroplanes. They killed about 1,300 people. Thus the number killed per ton went up from 12 to 32. However, Barcelona was practically undefended, owing to the "non-intervention" agreement. And it was crowded with refugees. Had it been defended the aim would have been worse and the casualties somewhat less. On the other hand there were bomb-proof shelters for about one sixth of the population. We may take 20 deaths per ton as rather a low figure for modern aeroplanes. Thus 500 aeroplanes carrying two tons each could kill about 20,000 people.

CHAPTER II

THE HISTORY OF AIR BOMBING

AERIAL BOMBARDMENT began in 1914, and the first German bombs were dropped on British civilians on Christmas Day of that year. London was not attacked until May 31st, 1915. The first raids were carried out by rigid Zeppelin airships, but single aeroplanes soon took part. It was not till 1917 that raids were carried out by squadrons of 'planes.

The total number of British civilians killed in these raids was 1,414, while 3,416 were wounded. These numbers are extremely small, in fact vastly fewer than the numbers killed by motor-cars or measles during a similar period. At the present time motor-cars kill 5,000-6,000 people per year, and measles 2,000-3,000. And in view of the fact that people tolerate fast motor-cars, and readily preventable diseases, their great objection to being bombed from the air is an interesting psychological fact. We shall see that it is not a universal rule.

Similar raids were carried out on French and Italian towns. It was only after a considerable time that retaliation against Germany was begun, and only in June 1918 did the British form an Independent Air Force for the purpose of bombing German towns. Besides this a larger number of raids were made by both sides against targets behind the military fronts,

but just out of range of artillery, and a good many casualties caused.

It may be said at once that the main effect of these raids was moral. If no one had taken the faintest notice of them, except to tend the wounded and bury the dead, the casualties would have been somewhat greater. But no aeroplanes would have been kept back to keep raiders off, there would have been no interference with the production of munitions, and the war would have been over somewhat sooner.

This fact is generally realized by Governments, which are therefore attempting to concentrate on preventing panic rather than on actual protection. This I believe to be incorrect, because the air raids in future wars will be on an altogether different scale from those of the 1914-1918 war, and will become wholesale massacres unless really adequate Air Raid Protection is given.

“POLICE BOMBING”

From 1918 to 1935 we heard very little about aerial bombardments. Nevertheless they continued. The British Air Force was largely stationed in Asia. Part of it was in India, and its enthusiastic officers believed that they had solved the problem of keeping order in the hills of the North-west Frontier province, where the tribesmen, like the Scottish Highlanders until the eighteenth century, combine passions for independence and for the property of their neighbours in the plain. The idea was that instead of sending an army to carry out reprisals, aeroplanes should be sent to give warning, and then, after the inhabitants had had time to

17680

evacuate their villages, these were to be destroyed by aerial bombardment.

We in England only hear one side of these activities. We do not know whether the warning ever miscarries, or whether some obstinate, ill, or infirm people stay behind and get bombed. The Japanese, however, make great play with the barbarity of these bombings, and find them extremely valuable when justifying their own conduct in China. It may be that not a single Wazir has been killed in raids of this type. In any case they have proved quite ineffective in keeping the peace. In 1937 an army of British and Indian troops was sent into Waziristan to chastise the Fakir of Ipi. They were no more successful than the Air Force. In 1938 that holy but obstinate man was still asserting his independence. Similar methods were employed in Southern Arabia. "It has been found necessary from time to time in past years to take air action against the recalcitrant tribesmen. Such measures are undertaken only in the last resort when other methods of pacification have failed. Adequate warning is always given to the inhabitants so that they may remove themselves from the area affected, and as a result the number of casualties has been very small," said Mr. Ormsby-Gore¹ (now Lord Harlech). It would be interesting to learn the proportion of women and children among these casualties.

Another section of the Royal Air Force was stationed in Irak, until that country became completely independent. Here it played some part in suppressing revolts, and seems to have been a good deal more

¹ *Hansard*, February 8th, 1938.

efficient and probably more ruthless than in Waziristan. For there are no caves and very little cover of any kind in the flat Mesopotamian plain or the deserts to the west of it and between the rivers.

The French Air Force achieved even more spectacular results. According to General Niessel¹ a single raid on a *souk* (village) of the Beni Zeroual, in Morocco, killed and wounded 800 people in a few moments. The Spaniards are also said to have used aerial bombardment in their conquest of the Riff. It is important to realize when we describe aerial bombardments as barbarous, that they aroused very little protest when they were employed against "inferior" races. Yet a baby with a bomb splinter in its stomach suffers equally whether its father happens to believe in Christ, Mahomed, Bakunin, or merely hard cash.

And we are all of us in danger now because we did not prevent the bombing of these defenceless peoples. Lord Londonderry at Geneva in 1938 was very willing to abolish air bombing "except for police purposes in outlying places." And the fact that the Abyssinians were dark in colour and not very highly civilized was one reason why the provisions of the League Covenant were not carried out on their behalf.

ABYSSINIA

In the Italian conquest of Abyssinia explosive bombs were used. However, the most striking innovation was the use of mustard liquid from aeroplanes. This was

¹ *Préparons la défense anti-aérienne.*

sometimes dropped in containers. One was torpedo-shaped, 4 feet long, and contained about 40 lbs. of mustard liquid.¹ Some were dropped on towns, e.g. on Daggah Bur and Sasa Baneh.² These injured 80 persons severely. They were therefore probably less effective than the same weight of high explosive bombs would have been.

. A more interesting and effective innovation was the spraying of mustard liquid from aeroplanes. This is described in the following letters, published in Appendix 2 of the Communication to the League of Nations from the Ethiopian delegation on May 9th, 1936.³

Appendix 2. Extract from "Report on my flight to Kworam on March 16th, 1936, and on the destruction of the airplane of the Ethiopian Red Cross Society."

March 17th, 1936.

. . . "On the next day (March 18th), we had ample occasion to observe how the Italian planes dropped mustard gas (Ypérite) in liquid form. A liquid solution is squirted directly from the planes, falling like a light rain covering a large space of ground and each drop that touches one's skin leaving a burn wound. We saw several hundred people, mostly civilians, old men, women, and children, with those dreadful wounds. I myself had my left hand and wrist burned from touching a bush in passing which had probably been sprayed with Ypérite. I also had a sensation of burning on my tongue and on the mucous membranes of my respiratory organs."

(Signed)

Carl Gustaf Von Rosen.

¹ *Times*, April 4th, 1936. ² *ibid.* April 11th, 1936.

³ Official number C.201.M.126.

Appendix 4. To His Excellency Belatengueta Herouy,
Minister of Foreign Affairs,
Addis Ababa.

. . . "In addition to the containers already described, the Italians flying over Kworam Plain at relatively low altitudes used the method of spraying gas from the machine. This method causes possibly more widespread injury and is certainly more difficult to escape from than the dropping of gas shells. From the fine rain of corrosive liquid which descends from the 'plane there seems little protection unless possibly something in the nature of a diving suit were devised; in any case the Ethiopian soldiers and peasants are not provided with even the most elementary forms of mask or protective clothing. Consequently, large numbers of them, subjected to this form of attack, receive ghastly injuries to the head, face, and upper parts of the bodies. I may mention as an example, that one evening when I was riding across Kworam Plain shortly after such a gas attack I came upon the British Ambulance Warrant Officer Atkinson administering first aid to victims. It had been necessary to send him down from the cave in which the Ambulance was then located because many of the victims had been blinded by the gas spraying and could not go up into the hills for treatment. After this it became a daily occurrence for the Ambulance to send officers down to the plain to treat victims thus incapacitated. On this evening in question, while I was present, Atkinson treated fully 100 cases of burning by corrosive liquid." . . .

. . . "All the facts here recorded were observed by me in company with other European witnesses."

(Signed)

Walter M. Holmes.
Correspondent of the Nordisk Telegraph
Agency, Copenhagen,
and for *The Times* at the Northern Front.
Reuters Bureau,
Addis Ababa,
April 11th, 1936.

According to Appendix 3 "Gas was sprayed on the town of Kworam on April 4th, 5th, 6th, and 7th, of 1938." No details are given as to its effect, though they might be of great interest to the inhabitants of British towns. Nor can I find any complete account of the method of spraying. According to Captain Townsend Stephens,¹ of the British Red Cross, "The gas is sprayed from an apparatus which is fixed to the wings of the 'planes. . . . We have treated about 3,000 of them during the last month, and of these about 20 in every 1,000 have died. After one raid 2,500 were affected by mustard-gas spray."

The spray seems to have been vastly more effective than the bombs. It is to be noted that the effects described are solely those of actual contact with drops of the liquid. Few if any casualties were caused by the vapour. Doubtless the Ethiopians evacuated the sprayed areas before they had had time to breathe much of it. However, they were caught in dense formation by the spray, and this is said to have been one of the principal causes of the Italian victory. The spray was also scattered on the hills on each side of the roads used in the Italian advance to prevent the Abyssinians from occupying them.

SPAIN

We now turn to Spain. The parts of Spain which remain loyal to the Republic have now been subjected to bombardments by Italian and German aeroplanes for two years. From October 30th, 1936 to January

¹ *News Chronicle*, April 4th, 1936.

9th, 1937 there were 35 raids on Madrid. I have been unable to discover the total casualties in these raids, nor indeed will they ever be known exactly, for many people were buried under huge masses of masonry, or literally blown to pieces so small as to be unidentifiable. In the early raids incendiary bombs were used, but these proved ineffective, although lurid descriptions were given in the press. One struck the British Embassy on January 9th, 1937, but the fire was easily put out.

There were no anti-aircraft guns available in the early days, though some arrived towards the end of this period, and the defence by fighting 'planes improved steadily. Although about 1,000 people appear to have been killed, and a good many more wounded, these raids were defeated by a new phenomenon—mass heroism.

I had been in Madrid before, and seen the people running for shelter. Indeed during a bull-fight in June 1933 a hail-storm had started, and the entire audience had run for shelter, leaving the bull and myself alone! And it was clear that the Spanish militia had run away from artillery bombardments which would have dislodged neither British, French nor German troops in 1914-1918. I therefore expected to find in Madrid something of the panic which prevailed in London in 1917, when according to Pierce, 300,000 people spent the nights in Underground railway stations, and 500,000 in cellars. A few people camped in one of the Madrid Metro stations, but I never heard of anyone sleeping in a cellar. It simply "wasn't done" to be frightened, though of course there were isolated cases. But on the whole everyone carried on.

In the first air raid during my stay there our first warning was the sight of a number of people leaning out of windows on the opposite side of the street to watch the fun. And it was very difficult to persuade people to take shelter, though I ultimately went down to the basement. During the second I also went down to a basement, but curiosity soon overcame caution, and I was one of large numbers of people who watched an air battle from the open.

This has not been the case all over Spain. After an air-raid on a village in December 1937, people ran out into the country with such vigour when they saw another squadron approaching that I could not help joining them, though I did not run as far as some, and stopped as soon as I found a suitable ditch. But although I have met people who say they have seen people running for shelter during a raid on Madrid I have never seen it happen myself. Even the trams did not stop.

No doubt this behaviour caused some extra casualties, but, as a man said to me when I suggested that we might run for a refuge, "We old chaps can't fight, and if we started running we should be setting a bad example to the boys in the trenches." The effect on military morale was tremendous. The militia rallied. They felt that they could not let such people down. If there had been a panic evacuation of civilians I think it is quite likely that the army would have run too.

It was only after Madrid had proved impregnable that large-scale raids on other towns became frequent. Among the most striking were those on Durango and Guernica in the Basque country. Durango was bombed

on a market day. Among the buildings hit were a church where the officiating priest and twenty-five others were killed at mass, and a convent where eleven nuns were killed. The story of Guernica is too well known to need repetition. It appears to have been at the same time an act of terrorism in which some 2,000 people were killed, many being roasted alive, and a technical exercise for the German air force. It was shown that incendiary bombs are quite effective if enough are used on a small area. Throughout April, May, and June, Bilbao was intensely bombarded. According to the *Daily Telegraph* of June 14th, 10,000 bombs were dropped on it in one day. The refugees were then attacked with machine-guns and light fragmentation bombs.

These operations no doubt had a considerable effect in causing the collapse of the Northern Front in Spain. Their success was largely due to the fact that no effective protest was made, and indeed in England they were vigorously supported by the Catholic press and hierarchy, a fact which has of course deprived the Catholic Church of its last shred of a claim to speak with any moral authority. Had the Basques been allowed to import anti-aircraft guns the German losses would have been very considerable.

But the success of these operations immensely strengthened the belief of the German Government in the value of their air force, and Marshal Goering was given a freer hand in its expansion. The failure of the British and French peoples to persuade their Governments to keep the Law of Nations is therefore likely to result in the death of very large numbers of British and French civilians in a future war. A feature

of the operations on other fronts during the summer was the use of incendiary bombs to set wheat fields alight¹ as a part of an attempt to starve the loyal Spaniards out. This may be regarded as a dress rehearsal for a similar attempt on Britain.

In September, after the collapse of the Asturian front, a large part of the Italian and German bombing aeroplanes were transferred to Majorca. So far the coastal towns had mainly been raided by aeroplanes based on Italian 'plane-carrying ships. Now the destruction became more systematic. "From Port Bou to Alicante there is hardly a town or harbour of any importance that has not been attacked by bombing squadrons from Majorca . . . this summer."²

In December 1937 a series of attacks on Barcelona was begun. They occurred largely at night. The raiding aeroplanes came from Majorca and generally dropped their bombs in the crowded slum area near the harbour. It must be remembered that an aeroplane flying at a great height and high speed can release its bombs several miles from its target, and then turn round. Thus by the time the bombs burst the aeroplane is already on its way back to its base. These tactics are likely to prove effective against towns on the Eastern coast of England and Scotland. As the anti-aircraft defence of Barcelona improved the raiders adopted new tactics. They rose to a great height, shut off their engines some miles out to sea, and glided down towards their objective, so that they could not be detected by listening posts.

¹ *Daily Telegraph*, July 13th; *Times*, July 23rd.

² *Times*, November 9th, 1937.

Such were the rehearsals for the great aerial offensive of Spring, 1938. But this offensive did not find the Spanish people altogether unprepared. During 1937 it had been realized that even where cellars existed they gave no protection against direct hits. A vast programme of digging was undertaken. This was done locally; and while one town might provide bomb-proof shelters for most of its inhabitants, another might do little more than strengthen existing cellars, and provide some kind of splinter-proof refuges for people in the streets—in other words carry out the maximum programme of the present British Government. But in the best protected towns the shelters were actually proof against direct hits by quarter-ton bombs. Rarely were there enough for the whole population. For example as late as May 1938 the Catalan town of Reus, which was well protected, had cellular reinforced concrete shelters (see p. 174) for 9,000 people and shelters under houses for 11,000, while shelters for 1,200 more were under construction. Even so this only accounted for 21,200 out of a population of 27,400. It is probable that the 6,200 unprotected people slept out in the fields.

In January 1938 the attacks on Barcelona were greatly intensified. Between December 15th and January 20th there were 77 air raids¹ killing 273 people, and wounding 456. Nevertheless during this time there was nothing like a general panic, although people in the streets did not disdain to run for shelter. However, life was fairly normal in between the raids, as I can testify. Indeed there was a little too much of

¹ *Manchester Guardian*, January 25th, 1938.

the "business as usual" attitude in some quarters. On January 31st there was a far more serious raid. Though they were carried out by only 6 Savoia 'planes in each of two visits, about 300 people were apparently killed. These included 83 orphan children in one house. While I am aware of the glorious record of the Italian Air Force, which has doubtless had a great influence in securing Mr. Chamberlain's friendship for their country, it is not every day that they can kill 83 orphans with one bomb. Their average is very much lower.

The extreme difficulty of arriving at facts is shown by comparing the figures given in different newspapers for the raid of January 31st. They vary from 1,000 in the *Herald*, *Mail*, and one estimate in the *News-Chronicle*, through 700 (another estimate in the *News-Chronicle*) to 300 according to the *Daily Worker*. The latter figure is, I think, the most accurate. The number of bombs reported dropped varied from 48 (*Telegraph*) to 24 (*Herald*). By the end of February the number¹ killed in Barcelona alone exceeded the number for the whole of England in 1914-1918.

Then in March a new storm burst. The Italian Army with some Spanish support attacked in Aragon after bombardments by a vast fleet, estimated as 700 strong, of German and Italian bombers. It is impossible, and may never be possible, to estimate the casualties caused in the towns behind the Aragon front. A squadron of 20 or more bombers would come over a town and drop their bombs simultaneously, so that the shock and blast effects of the different explosions were added.

¹ *Manchester Guardian*, January 28th, 1938.

Tortosa was reduced to rubble like many French towns in 1914-1918. Sections of the army ran away. In an attempt to win the war by a knock-out blow Barcelona was again bombed. From 10 p.m. of March 16th to 3 p.m. of March 18th there were 13 raids. In none of them did more than 9 bombing aeroplanes take part. It is estimated that 41 tons of bombs were dropped, the majority weighing one or two hundredweight, whilst some weighed half a ton. 1,300 people are said to have been killed, and 2,000 wounded.

As this series of raids probably gives the best idea of what we may expect in a future war, the details are of interest. Those given¹ by Mr. Duncan Sandys, M.P., are of particular interest, since he is a conservative, and is unlikely to exaggerate facts in such a way as to discredit the value of the precautions taken or proposed by the present British Government. He states that the incendiary bombs weigh about 35 lbs. (others say 50 lbs.) and that about 60 per cent fail to ignite. Of the remainder probably only 15 per cent fall on houses, so that about 700 lbs. of bombs are needed to start a single fire. Hence "the fires which they ignited have not led to any widespread outbreaks, and the regular fire brigades have found themselves well able to cope with them."

The main effect was from lateral blast and shock. "In one place I measured the frontage of the buildings that had been totally demolished, and found that it was well over 200 feet in length. That is equal to about a dozen or so average-sized London houses. As might be expected, the buildings actually struck

¹ *A.R.P. News*, Vol. I, No. 1.

and those on either side of them have been reduced to a heap of shattered rubble. But in addition to this, other houses over a wide radius have suffered serious damage. Sometimes several hundred yards away windows and doors were blown in, steel shutters crumpled up, balconies ripped off, and partition walls, ceilings, and floors knocked down by the terrific blast of the explosion."

These raids succeeded in doing what the others had not, namely in creating a panic. About a quarter of the population ran out into the country. Some were of course killed in the streets by splinters or blast. Others lost their heads completely, and tried to dig holes in the streets. Owing to the density of the population, which includes half a million refugees, it had been impossible to make even approximately bomb-proof shelters for more than a fraction of them. There are nearly two million inhabitants, and the number for whom shelters exist has been given at 600,000. I believe the true figure to be a little over half this.

Nevertheless, the fact that a huge effort is being expended on these shelters, and that they are quite effective, has had a vast moral effect. The people realize that every day which they can hold out increases their safety. And the panic which occurred was partial. The Government kept its head, and there was no threat of a revolution to end the war.

Soon after this the Spanish Government were able to construct a new fleet of fighting aeroplanes. They cannot obtain them direct from abroad since they can only fly for two hours or so at a time. They have also improved their anti-aircraft defence. Fifty-eight fascist

bombers were brought down in one month. At the time of writing (June) the fascists were engaged in bombing British ships and French territory.

One point must be emphasized. It is extremely difficult to hit a given object. During over 100 raids none of the three bridges in Sagunto carrying vital roads and railways has been hit. An attempt to destroy the bridge at Tortosa by dive-bombing led to the destruction of the aeroplane. Whereas artillery, though they miss the object aimed at first, generally hit it in the end, because they can correct their aim, particularly when they have aerial observation to direct their fire. Hence even when military objectives are aimed at, the main casualties are civilians. Of course in the raids described above the objectives were rarely military.

The total number of civilians killed in these raids is unknown. Up to May, 1938, 10,760 children are known to have been killed. The number of adult civilians killed is probably at least four times as great. Besides this a larger number have been wounded, many being permanently mutilated. The psychological effect varies in different cases. Many of the older people, especially women, are hopelessly demoralized. Their morality was built up around the Catholic religion, and the realization that the Pope is blessing those who murder their children creates, so to speak, a moral vacuum. Their religion has proved worse than useless, and they have nothing to put in its place. Life and death seem equally meaningless to them. A few, but not many, go mad. Some of the children are also reduced to terror. But from five years upwards, many

of them learn what the war is about, and show as great courage as the adults.

The state of these latter is commonly one of moral indignation so fierce as simply to overpower fear. In the talk of ordinary working people about raids, the commonest word in the vocabulary is "criminal." During a raid, reactions are very various. Usually there is a tightening of the muscles, a tense waiting for the bombs to fall. Some people talk volubly, others are silent. People who have been in several raids often say, "I shall never be hit." Personally I generally think that I shall be killed, and say to myself, "Well, well, so this is the end of me. How curious." After the raid there is a great feeling of relief until one sees a few smashed corpses and mutilated people, or hears a man whose intestines have been torn out, howling like a dog. But the cumulative effect of a number of successive raids is terrific. Any brave man can stand one raid. To stand a number requires military discipline, mass heroism such as is found in Madrid, or a philosophy which makes it clear why these things happen, and why the final victory of fascism is impossible. A dying Marxist can say with perfect confidence:

"Exoriare aliquis nostris ex ossibus ultor."¹

CHINA

The air raids of the Spanish war have been almost trivial compared with those of the war in China. The main technical differences have been that incendiary

¹ "Out of our bones let some avenger arise" (Virgil).

bombs have been more effective, owing to the larger number of wooden houses, and that apparently far less has been done in the way of digging shelters. I have been entirely unable to obtain any estimate of the number killed in air raids. But in Canton alone this must far exceed 10,000.

The Japanese have paid particular attention to attacks on road, railway, and river traffic, in the course of which they created interesting precedents by shooting a British ambassador and sinking an American warship. The air raids have had little or no direct military effect. Nanking was taken by infantry and tanks. It did not surrender as a result of air raids. On the other hand the disorganization caused by these raids must have played its part in obstructing the operations of the Chinese armies.

The Chinese have so far made one air raid on Japan, in which they dropped leaflets. Only posterity will be able to decide whether so eminently civilized a procedure was correct, or whether they should have murdered Japanese civilians, as members of any other nation would have done.

INTERNATIONAL LAW

It is quite doubtful how far air raids are illegal. The British Government claimed, probably correctly, that the German raids on Britain were so under pre-war international law. In 1922 a draft convention¹ was drawn up at the Hague by which aerial bombardment of anything but military objectives was forbidden. The following are extracts:

¹ Miscellaneous No. 14 (1924), Cmd. 2201 (H.M. Stationery Office).

"ARTICLE 22. Aerial bombardment for the purpose of terrorizing the civilian population, of destroying or damaging private property not of military character, or of injuring non-combatants is prohibited.

"ARTICLE 24. (1) Aerial bombardment is legitimate only when directed at a military objective, that is to say, an object of which the destruction or injury would constitute a distinct military advantage to the belligerent.

"(2) Such bombardment is legitimate only when directed exclusively at the following objectives: military forces; military works; military establishments or depots; factories constituting important and well-known centres engaged in the manufacture of arms, ammunition or distinctively military supplies; lines of communication or transportation used for military purposes.

"(3) The bombardment of cities, towns, or villages, not in the immediate neighbourhood of the operations of land forces is prohibited. In cases where the objectives specified in paragraph 2 are so situated that they cannot be bombarded without the indiscriminate bombardment of the civilian population, the aircraft must abstain from bombardment."

It is a horrible fact that these rules were never signed on behalf of all the States concerned, and are not now part of international law. It appears to be quite legal, once a state of war exists, to bombard any part of London.

In 1925 the representatives of the leading powers signed a treaty¹ from which the following is an extract:

"The undersigned plenipotentiaries, in the name of their respective Governments:

¹ League of Nations Document A.16.1925.IX.

"Whereas the use in war of asphyxiating, poisonous or other gases, and of all analogous liquids, materials or devices, has been justly condemned by the general opinion of the civilized world; and

"Whereas the prohibition of such use has been declared in Treaties to which the majority of Powers of the world are Parties; and

"To the end that this prohibition shall be universally accepted as part of International Law, binding alike the conscience and the practice of nations;

"Declare:

"That the High Contracting Parties, so far as they are not already Parties to Treaties prohibiting such use, accept this prohibition, agree to extend this prohibition to the use of bacteriological methods of warfare and agree to be bound as between themselves according to the terms of this declaration."

The signatories include Germany, Italy and Japan.

Attempts made in 1932 to prohibit bombing aircraft altogether were a failure. While it may be unjust to place the entire blame for this on the British representative, Lord Londonderry, it is worthy of note that he said in the House of Lords on May 22nd, 1935, "I had the utmost difficulty at that time, amid the public outcry, in preserving the use of the bombing aeroplane, even on the frontiers of the Middle East and India."

At that time the following argument could still be brought forward: "It is true that bombing aircraft have not been abolished nor their use limited. But the nations are solemnly pledged under the Kellogg Pact not to resort to war. And if one should do so the remainder are mostly pledged under Article 16 of

the League Covenant to impose sanctions which would speedily bring war to an end."

This argument would have been valid had it been certain that Article 16 would be carried out. The relevant part of this Article reads as follows: "Should any member of the League resort to war in disregard of its covenants under Articles 12, 13, or 15, it shall *ipso facto* be deemed to have committed an act of war against all other Members of the League, which hereby undertake immediately to subject it to the severance of all trade or financial relations, the prohibition of all intercourse between their nationals and the nationals of the covenant-breaking State, and the prevention of all financial, commercial or personal intercourse between the nationals of the covenant-breaking State and the nationals of any other State, whether a Member of the League or not."

It is a matter of common knowledge that Italy broke the Covenant, the Kellogg Pact, and the 1925 treaty concerning gas, that the British Government did not apply Article 16, and that its representative at Geneva voted against its application.

As a result of these actions International Law no longer exists in any serious sense, and there are excellent precedents for every kind of violation of it, including the destruction of any village in Britain however remote from any warlike activities.

WHAT WE MAY EXPECT

At the present time our most likely enemy is Germany. I am not one of those who believe war to be inevitable,

for the good reason that several wars considered inevitable by experts in the past did not occur, for example a war with Russia about 1880, and one with France about 1900. I do not say, with Earl Baldwin, that our frontier is on the Rhine. Nevertheless, I know that such a war is quite probable. If we were fighting by the side of France, the Soviet Union, and other powers, we should only have to face a fraction of the German Air Force, though the navy and parts of our own air force might be engaging Italy and Japan. If we were alone, as the result of a policy of isolation, the entire German Air Force could be directed against us.

An air attack might take two forms, a knock-out blow or an attempt to wear our resistance down. The former would be directed against London, the latter also against ports and munition centres. If our enemies expected a long war, there is half a square mile of Sheffield which is more vital for the production of munitions than any other part of Britain.

The Germans appear to be building about 500 aeroplanes a month. Some are fighters, and training and reconnaissance machines. The majority are probably bombers with a sufficient range to enable them to reach Britain from the nearest German aerodromes and return. In the Spanish war the German and Italian bombers show great caution. In fact they usually scurry for safety when attacked by smaller numbers of loyalist fighters. Doubtless Hitler and Mussolini do not want to lose a large fraction of their air forces in a side-show. In a knock-out blow this would not be the case. They would be prepared to lose half their air force to lay London in ruins.

We may therefore expect an attack by successive waves of several hundred aeroplanes which would drop their bombs almost simultaneously. A bombing aeroplane can carry a load which varies from half a ton upwards. But we may take $1\frac{1}{2}$ tons as an average. Thus a squadron of 270 'planes could drop 400 tons of bombs, or nearly double the total weight dropped in Britain during the whole of the last war, in half a minute. This would probably kill about 8,000 people, and wound some 15,000. And this could be repeated several times a day, provided the enemy were willing to stand the heavy losses of aeroplanes involved. In fact the "knock-out blow" might kill 50,000 to 100,000 Londoners.

Now such losses as these do not necessarily cause panic. During the influenza epidemic of 1918-1919, over 200,000 people died in Britain, and probably 50,000 in London. But there was no panic. People did not flee into remote villages or shut themselves up in their houses. They were far less frightened than by the air raids. But we have been so conditioned to hate and fear other human beings rather than our real and natural enemies, the bacteria and viruses which cause disease, that only a deep moral change would enable us to remain calm during a bombardment which killed even one per cent of the population of London. Though we do remain calm under conditions of malnutrition and bad housing which kill this number of people per year. The Government is entirely right in saying that the importance of calm and courage is immense.

But mass heroism cannot be made to order. People

will only remain calm and brave under such a trial if they are absolutely sure they are dying for something worth while, and that, as people say in Spain, it is better to die on your feet than live on your knees. They are willing to die for liberty if the issue is put before them in simple words by men and women whom they can trust absolutely, and who are risking their own lives beside them, men and women who tell them the truth, and make every possible effort to save them. But they must be absolutely convinced that they are dying for their own freedom, and not for the aggrandisement of others, that no one is making profits out of the war, and that it will cease when the simple objectives put before them are gained.

These conditions are pretty nearly completely fulfilled in Loyal Spain. They were not fulfilled in Britain during the last war. They are unlikely to be fulfilled during the next. If vast profits are being made out of the war, if rich men and women are in safety while poor men and women die, it is useless to suppose that the exhortations of even a million Air Wardens will conceal these facts.

The question therefore remains whether it is possible to give the people of Britain a protection so complete that the knock-out blow will not even be attempted. I shall try to show that this is the case.

One last word on probable tactics. If London is not laid waste in a week, there will be raids not only on important towns but on towns and villages of no military value, to create a demand that each town should have its anti-aircraft battery, and thus to weaken the defence of vital points. This is happening

in Spain today. Indeed some experts think that the main attack will not be on London at all, but on the great towns of the North and Midlands, which are less adequately defended, and where the defending planes would be harder put to it to find their prey. Thus up till the last moment it would not be clear whether an attacking squadron was making for one of the great Yorkshire cities, for Lancashire, or for Derby. It is well that people living in areas of no military importance should realize this fact. A.R.P. is vital, not only to those who live in large towns and near military centres or factories, but to every man, woman, and child in Britain.

CHAPTER III

KEEPING BOMBERS AWAY

IN THIS SHORT chapter I shall say something about the methods of air raid defence which come into play before the bombs are dropped. The Government's A.R.P. handbooks do not of course deal with this matter, except in relation to black-outs.

FOREIGN POLICY

The best way to avoid being bombed is to avoid war. I cannot here deal with the question of foreign policy except to point out two facts. Since the British Government abandoned the policy of collective security, the danger of war has enormously increased. This is now universally admitted, and is of course the reason given for the present huge re-armament programme.

The British Government has done nothing to stop the wholesale murder by bombing aeroplanes of civilians in Abyssinia, Spain and China. Its representatives have gone so far as to defend this action (e.g. Mr. Butler, Under-Secretary of State for foreign affairs, when questioned on May 2nd regarding an air raid on Valencia in which two British seamen were killed). If Valencia is a legitimate military objective, so is London.

It is often forgotten that in wars before 1914 both sides often respected international law even when it

was to their military disadvantage. The British foreign policy of the last seven years has, to say the least, made this less likely to happen in the future.

ADEQUATE PASSIVE DEFENCE

If the rulers of a foreign State realized that air raids on Britain were unlikely to produce a decision, it would be unlikely to attempt them. For air raids causing slight casualties would endanger the hostile air fleet, and would merely strengthen the morale of the British people while inviting reprisals. It will be shown later that British passive defence is very inadequate, but that it could be made adequate. Thus purely defensive measures would lessen the likelihood of a war, without causing alarm abroad, as offensive armaments certainly do.

INTELLIGENCE

Once a war has begun it is of the utmost importance to get the earliest possible information of the approach of hostile aeroplanes. Here several methods are possible. Spies in hostile territory might be of great value, especially if equipped with short-wave radio sets. Agents in neutral countries (e.g. Holland and Belgium in the event of a war with Germany) could give similar information as to aeroplanes passing over them. British ships at sea might be able to detect them before they reached the coast. It is possible that enemy radio messages could be tapped, but they could hardly be decoded in the short time available.

On the approach of hostile aeroplanes to the coast they can be detected by sound at a distance which varies with the weather and other factors, but is not likely to exceed twenty or thirty miles, say five minutes' flying distance. Other means of detection are possible, for example detection by infra-red radiation, which travels through haze. The French coast has been photographed from an aeroplane over London, eighty miles away, by this means. It is, therefore, theoretically (but perhaps only theoretically) possible to detect an aeroplane from the ground at this distance. However, if any new methods have been developed, they are official secrets.

BLACK-OUTS

Really effective extinction of lights can go a long way to hide a town. Unfortunately certain towns, and particularly London, Hull, and Edinburgh, are near conspicuous landmarks on the coast, and would hardly be missed. And in the last twenty years blind flying has been greatly developed. So we can hardly hope that the enemy will be as completely mistaken in a future war as were the Germans when they claimed to have bombed Manchester and Birmingham in 1917. Nevertheless a small inland town could be completely protected on a moonless night. I shall later consider the steps which have so far been taken to secure this effect.

DEFENSIVE AEROPLANES

Bombers can be attacked by fast fighting aeroplanes armed with machine-guns or light cannon. As the

modern bomber is largely made of metal, it is much less vulnerable than the aeroplanes used in the Great War. Moreover fighting is much more difficult at very high speeds than was then the case.

The defensive fighter is built for very high speeds, up to 400 m.p.h. or over, and particularly for great climbing power. The speed of bombers is also anything up to 300 m.p.h. Under these conditions aiming becomes extremely difficult and some authorities think that even if fighters reach the bombers, they will bring down a smaller proportion of them than in 1914-1918.

The tactics of the Spanish war do not help us much. There the bombing squadrons are generally protected by an almost equal number of fighters. In the only air battle which I witnessed, about 25 German bombers and 15 fighters came over Madrid. They were attacked by some 20 very fast loyalist fighters. These were engaged by the German fighters whilst the German bombers retreated, dropping their bombs rather ineffectually. A great many machine-gun bullets were fired with little effect. One loyalist fighter was hit, but as it fell its pilot rammed a larger German fighter, and both fell together outside the city. All the men in both were killed. They were the only casualties apart from about twenty civilians killed by the bombs.

Now a fast fighter generally only carries a petrol supply for two or three hours. So a squadron raiding England would have to protect itself. It may be that its casualties in a fight would be greater. Unfortunately, only experience can show. There is

no doubt, however, that fast British fighting aeroplanes will be of some value in defence. It is therefore a tragic fact that the main effort of the British re-armament programme in the air has been concentrated on bombers rather than fighters, the proportion of fighters being under one third. It may be that a general-purpose machine will later be developed.

BALLOON BARRAGES

In 1917 London was protected by a line of balloons moored by wire cables. These rose to a height which I have variously seen given as from 8,000 to 13,000 feet, and had a considerable moral effect. If London were surrounded by a ring of such balloons 100 yards apart, and were attacked by bombers with a wing span of 100 feet flying below the balloons, one in three would hit a cable, and many of these would be brought down.

Unfortunately, however, the balloons must be hauled down in a high wind, and even in a moderate wind cannot rise to the full height. The limit to the height is due to the following fact. As the balloon rises higher the weight of cable to be held up is greater. Hence the cable must be thicker at the top than the bottom, like the stalk of a pea plant. Thus the weight of cable to be lifted increases more than proportionately to the height. It is said that this difficulty can be met by attaching several balloons in tandem to the same cable. Doubtless the balloons and cables have been improved, but the climbing power of bombers has been increased still more. So it is certain that enemy bombers could

get over any balloon barrage, though by flying so high they would use up petrol and their aim would become less accurate. But they could be sure of dropping their bombs somewhere in London, except in very cloudy weather.

ANTI-AIRCRAFT ARTILLERY

Good anti-aircraft guns are effective against aeroplanes unless the latter are flying very high or very low. If they are flying very low they are out of sight before the gunners have time for more than a single shot. If very high the aeroplane will have moved a long way before the shell reaches its level, and the pilot will have had time to change his course.

In Spain anti-aircraft guns proved more effective than had been expected. As soon as the loyalists obtained any appreciable number of them, raids on Madrid ceased (about February 1937). And at first they did a good deal to protect Valencia and Barcelona. However, in recent months the raiding aeroplanes have flown so high as to be almost if not quite out of their reach. This would probably not be the case if modern guns were available to deal with the modern bombers. And on the rebel side the German anti-aircraft artillery seems to have proved a good deal more effective than the German fighting aeroplanes.

Hence the provision of anti-aircraft guns is of the utmost importance for Britain. This provision has been grossly neglected. In the spring of 1938, according

to the *Sunday Times*, the 47th Territorial Division, which is charged with the defence of London, was still armed with guns of a type designed in 1913, and adapted for anti-aircraft use during the Great War. At present Britain is said to be importing anti-aircraft guns from Sweden, although as early as 1933 Hitler and Goering had proclaimed their intention to build a great fleet. One may hope, but can hardly trust, that things will be better by the time this book is published. At the time of writing Mr. Hore-Belisha boasts proudly that some Territorial units have enough of these guns for training purposes!

SEARCHLIGHTS

Searchlights are an essential aid, both to anti-aircraft artillery and to fighting aeroplanes during night raids. Unfortunately, however, they are somewhat less valuable in a cloudy and foggy climate like that of England than in the clearer skies of Spain.

NEW WEAPONS

It is earnestly to be hoped that some other method may be discovered for bringing down hostile machines. Various forms of ray have been suggested, including rays to upset the ignition system, or explode the bombs, and heat rays to burn up the 'planes. Clouds of poisonous or explosive gas, or of dust to choke the motors have been proposed, along with many more fantastic devices.

Unfortunately none of these appears to be practicable. A ray which works well enough at ten feet is completely futile at ten thousand, just as clockwork will drive a train on a 4-inch gauge, but not on a 4-foot gauge. The amounts of gas needed to stop aeroplanes must be measured in cubic miles.

BOMBING ENEMY AERODROMES

One argument used by the advocates of bombing aeroplanes as defensive weapons is that it is easier to destroy enemy aeroplanes on the ground than in the air. There is some truth in this, and in consequence the Germans are very busily building underground shelters for their aeroplanes, though not on any great scale for their civilians. Besides destroying aeroplanes and buildings, bombs can be dropped on the aerodromes. The craters made by their explosion can be filled up, but the soft ground causes accidents to heavy aeroplanes, both when taking off and when landing.

If, however, the enemy has large numbers of aerodromes, some will be unoccupied at any given time. Further, aerodromes will be invisible at night, and well defended during the day. Attempts at bombing aerodromes will only too easily pass over into:—

BOMBING ENEMY CIVILIANS

This measure has undoubtedly two effects which are desirable from a military point of view. When industrial areas are bombed, work on munitions is

greatly slowed down. A single air raid, even by a few machines, caused on an average two hours' loss of work in the munition works of the Mannheim area of Germany in 1917-1918, even if neither factories nor workers were hit. In August 1918 one single factory received 53 alarms. In January 1916 munition factories as far apart as Nottingham, Worcester, Gloucester, and Bath were stopped as the result of the report of a single air raid. The mere necessity for putting out lights at night is a great handicap to production.

As against this it is reported that although up to June 1938 Sagunto had been bombed 138 times, the munition workers of that city had not lost a single hour's work. I am inclined to believe that this statement is true, at least for some factories. But I certainly should not have believed it had I not spent some months in loyal Spain. And I do not ask my readers to believe it. In any case such behaviour is most unlikely in England or Germany. It was only made possible for Sagunto because, during the first months of the war, the workers of Sagunto spent a great deal of time, during which they could have been making munitions, in organizing themselves on a democratic basis which has enabled them to stand up to suffering and danger which men organized on a capitalistic basis cannot stand.

Secondly the necessities of defence keep a large portion of the enemy air force at home. True the defensive machines are fighters, but their pilots might be used for bombers. The ratio of defending to attacking aircraft may be as high as ten to one. Whatever the validity of this argument, it will certainly

be used to justify bombing of enemy civilians if Britain is involved in a war.

Nevertheless I believe that such murder is not only morally wrong, but militarily ineffective, provided that those who are bombed honestly believe that their Government is doing all that it can for them. This is the situation in Spain. In 1936 the average man or woman in loyal Spain regarded the war as other people's business. The people of Barcelona or Alicante were quite prepared to defend their homes if need be, but considered it an act of generosity if they sent volunteers to defend Madrid. They now realize that the war affects them vitally.

All over the world the vast masses of the people hate war, and will only fight unwillingly. Particularly in Germany and Italy they have become accustomed to the warlike propaganda of their own Governments, and it is hard to see how this propaganda can be greatly intensified even during a major war. But enemy bombs will be a new and effectual form of propaganda. It is very difficult to feel fraternal love for people who made the bomb which has just killed your wife and child.

A few British bombs on German towns (which I hope and trust will never be dropped) would do more to counteract the real and deep anti-war feeling which still exists in Germany than any amount of Nazi propaganda. After some years they might produce war-weariness, but the example of Spain has shown that the bombing of civilians is most unlikely to win a war outright, and, on the contrary, serves to prolong it.

There is one condition under which a few big air raids might cause a revolution. Such a result is possible if a people believes that its Government has recklessly embarked on aerial war without taking any steps to protect its own people against the inevitable consequences.

LIBRARY OF
EWING CHRISTIAN COLLEGE

CHAPTER IV

THE GOVERNMENT'S
PRECAUTIONARY MEASURES

I SHALL NOT ATTEMPT to deal with the efficiency or otherwise of the British Air Force and anti-aircraft artillery. It is sufficient to point out that the former is being heavily criticized at the time of writing by Members of Parliament belonging to all parties. I do not propose to add to this chorus for a simple reason. If I do not write the truth I shall be denounced as a liar and a panic-monger. If I do I shall be prosecuted under the Official Secrets Act. I could wish that our representatives would pay a little more attention to the problem of anti-aircraft guns. It would seem that the few efficient ones are being given to the Regular Artillery, who will presumably have to defend the British Expeditionary Force in a future war. The Territorials who will play the main part in defending our cities are not so well off, although as they include a number of highly skilled technicians, some of them are better gunners than the average Regular.

I shall confine myself as far as possible to an examination of the British official publications, that is to say Handbooks, Memoranda, Home Office Circulars, and the Air Raid Precautions Act of 1937. There is a good deal of "padding" in some of these documents, which is natural enough, for there is very little substance. Others are concerned with administrative

details, forms to be filled in, and so on. But a few of them are really important. I shall be particularly concerned with the one which is intended for the ordinary citizen, and is entitled, *The Protection of Your Home Against Air Raids*.

THE PEKES' PANIC

"If you live in a large town, think whether you can make arrangements for children, invalids and elderly persons and pets, to be sent away the moment danger threatens, so that they may be in a place of greater safety."¹

I am entirely in favour of all members of these classes being sent away. But I do not like the instruction to think. Some people might think too much. Those who cannot make arrangements of this sort might even think that there was something wrong in the fact that the Pekinese dogs of Berkeley Square should be hurried off into the country whilst their own children stayed behind to be bombed. Perhaps it is better not to think too much along these lines. It might lead to "dangerous thoughts," as they are called in Japan, thoughts which endanger the stability of a social system where dogs and cats are better treated than children and old people. So I, for one, shall ignore this order. My two-cylinder Jowett will not be used to take Toby to Perthshire. Toby will have to put up with the same risks as Johnny Smith next door.

"If ever you receive warning that war threatens, do these things at once:—

.....
4. If you live in a large town, children, invalids, elderly persons, and pets, should be sent to relatives or friends in the country, if this is possible."

¹ *The Protection of Your Home against Air Raids*, p. 5.

Just what this warning will be is not so clear. Are we to wait for an official warning, or to consult our own judgement, after carefully reading the statements of Hitler and Mussolini on this topic, or those of Mr. Duff-Cooper¹ (then Secretary of State for War), which are as follows:

"People—none of them British—are writing books advocating that the first blood (? blow) in a war should be struck before the declaration. They are the voices of great international figures. We are not safe in presuming that, should war occur, any preliminary declaration will be made. Therefore those engaged in the service of defence against air attack should be most ready to defend what was our last line but is now our first—our homes, our great centres of population.

"Are we prepared for an unannounced attack? We are no more prepared than we are as individuals against murder."

I fully agree with this passage. I shall not quote it again in full, but I ask readers to keep it in mind, for it entirely stultifies not merely our present policy on evacuation, but our policies on respirator distribution and trench-digging.

But supposing the danger becomes as obvious as it was, say on August 1st, 1914, what will happen? We shall have an unorganized evacuation of London and other big towns by a minority. Those who remember 1914 will also remember that during mobilization railway traffic for civilians was pretty completely disorganized. They will rely on motor-cars. Motor-

¹ Quoted from Hyde and Nuttall, p. 5.

coaches will take a certain number. But as people will naturally prefer villages to towns as bolt-holes, many of the refugees will be making for points off the main lines. The rich will use their own cars. Any family with £5 to spare and a relative in the country will hire a car to save their children's lives. There will be an appalling chaos on the main roads out of London, and the first air raids may not be on Central London at all, but on the traffic jams around it. In Spain, at any rate, the German airmen seem to prefer to attack concentrated traffic, whether on wheel or on foot, rather than to bomb buildings, when they have the choice.

The sight of this traffic stream will arouse intense resentment in those whose children are left behind. For not all the refugees will be children and infirm people. If we may judge from the experience of 1917 a good many able-bodied men will consider their lives too valuable to risk by remaining in the towns. There may be actual violence. Some mothers may commandeer places in cars for their children, even if Fido has to run behind.

Whether or not this occurs, the effect on morale will be lamentable. Those who are not so fortunate as to have the means of escape will be filled with a not unjustified resentment. They will furnish the raw material for panic and rioting which the Government rightly wish to avoid. If I believed the stories of Bolshevik plots I should almost be tempted to believe that these instructions were the result of one, intended to kill two birds with one stone; to ensure on the one hand a massacre of the rich, and on the

other an intense feeling of resentment among the poor.

These disastrous consequences can be avoided if for the unorganized evacuation of a fortunate minority we substitute the organized evacuation of certain categories, regardless of their economic situation. The question of organized evacuation is dealt with in Chapters VII and VIII.

After reading the quotation at the head of this section, which is taken from a document signed by Sir Samuel Hoare, it is interesting to turn to his speech¹ of June 1st, 1938. "Supposing it is necessary to organize an evacuation of this kind, what steps should be taken to prevent a scheme of this kind from becoming simply a class evacuation of people who have their own cars, who have their own means which enable them to stay with friends in the country?" No answer was given. I suggest that the first step would be the removal of a minister who asks the House of Commons what steps he is to take to undo the effects of a document issued over his own signature three months earlier. The thing would be funny if it were not tragic.

LIGHTING RESTRICTIONS

These are of particular importance, because they are a form of collective security. If I lose my respirator or go onto the roof during an air raid I only endanger my own life. But if I leave a light shining through an uncovered skylight I endanger the King in Buckingham Palace and the Prime Minister in Downing Street.

¹ *Times*, June 2nd, 1938.

The danger is even more serious in the country. Enemy bombers are unlikely to miss London in a night raid even if they do not know just where they are dropping their bombs. On the other hand, inland towns should be completely invisible on moonless or foggy nights. And a single bright light may betray them. Such a town as Lincoln, for example, is not a major military target. But there are a number of aerodromes near it, and if it were bombed their supplies might be affected, and some of their personnel killed or wounded. It would not be a sufficiently important target for a very big force, and a small force by day would probably be in danger from British fighters. But a dozen or two night-bombers could cause great damage to it with good hope of escape, provided they could find it.

The lights to be hidden or put out may roughly be classified as follows:

1. Street lamps.
2. Illuminated advertisements.
3. Lights in factories and business premises.
4. Lights in private houses.
5. Lights of motor vehicles.
6. Lights on or in railway trains.
7. Military lights.

During the Great War street lamps were dimmed, but not put out. This may be sufficient for London, which in any case can hardly be hidden. But the dimming of street-lamps will take days or weeks, and they should be extinguished. And in small towns the

street lamps should be put out for the duration of the war, as they are in loyal Spain. I hope that orders to this effect have been given, but the general public does not know. We are merely told¹ that "normal street lighting would not be permitted." And if only to reassure them, and to encourage them to screen their own lights, they ought to be told what is being done.

Illuminated advertisements, we are told² "would be prohibited" in time of war. But as a special Order in Council would probably be needed to do this, I confess that I should like to know whose business it is to see that these things are extinguished before, and not after, the first raid in what will probably be an undeclared war. Once again, all this may already be worked out in detail. But if so why not tell us? It would be of some value to the Government from the point of view of propaganda, to do so.

Instructions are given in the same Handbook for restriction on lighting of factories and business premises. External lights are to be forbidden except where authorized in connexion with essential work, and even here they must be put out on receipt of an air raid warning. In order to prevent internal lights from being seen, arrangements are to be made for darkening windows and skylights with paint, blinds, or both. Lamps of a low power are to be stored where possible, and so on.

The instructions to ordinary householders³ are of the same kind. We are to buy dark blinds and thick curtains,

¹ A.R.P. circular of February 14th, 1938.

² A.R.P. Handbook No. 6, p. 22

³ *The Protection of Your Home*, pp. 6, 12.

and also black paint or thick paper to cover skylights, fan lights and glass doors. "If necessary get these things now, because in an emergency the shops might be quickly sold out." When we receive warning that war threatens we are to make the needful preparations.

Now here two points arise. I can afford a pot of paint, and even several new sets of blinds. But one of my neighbours, Mr. John Smith, has been out of work for eighteen months, and has six children. He cannot afford to buy them the boots and butter which they need. He is certainly not going to buy paint and blinds now. And even if war comes, and the shops are not sold out, he will not be able to do so. As a result he will probably show a light, and my life, not to mention the King's, will be endangered.

Even if I took the view, which I do not, that the poor deserve less protection than the rich, I think that Mr. Smith ought to hide his lights as part of our collective protection. As he cannot afford to do so, I think that the Government, or even the municipality, should help him to do so. For this purpose paint and other necessities should be stored for issue in the event of emergency.

Another of my neighbours, Miss Irene Jones, presents a different problem. She can afford paint and blinds, but she is an absolute pacifist, who says that she will have nothing to do with war (though I believe that she contributes to rearmament by paying income-tax and even buying an occasional packet of cigarettes). She says that she is going to keep her lights on, and if a bomb hits her house she will be well out of a wicked world. As I have never yet seen a bomb hit the mark

at which it is aimed, I think it is much more likely that a bomb aimed at her skylight will hit me.

Now as far as I can see she is not at present breaking the law, and though I don't agree with her views, I respect them; and I respect her for standing on her legal rights. If lights should be covered, as I think they should, in the public interest, then this should be made a matter of law, like the lighting regulations for vehicles. Apparently at the present time under the Air Raid Precautions Act, 1937, "The Secretary of State may . . . make regulations for the purposes of this Act and such regulations shall provide . . .

(c) for the matters as to which provision is to be made by air-raid general precautions schemes. . . ." I suppose this paragraph would cover a regulation regarding lights, which would then have the force of law. Until this is so I have considerable sympathy with those people who refuse to take part in experimental black-outs. Some of them are said to have been forced to put lights out. If so it was an illegal action by Government servants, and an extremely bad precedent. Unless there is some legal means of dealing with Miss Jones she may find herself illegally assaulted by an air-raid warden, or even lynched by a crowd as a spy, which she certainly is not.

At the present time she is contending, like Hampden, for the great principle of English Law that no one can be compelled to do something merely because the Government would like them to do so. If the law is clear, I think she will obey it, as she obeys the law about income-tax. But I do not think Parliament would dare to pass a law by which John Smith could

be imprisoned because he cannot afford a pot of paint. On the other hand I am not at all sure that Sir Samuel Hoare might not issue a regulation which would have this effect. So it is up to Parliament to legislate in such a way as to bring my two neighbours into line without injustice to either.

Besides a house, I own a car. I have searched vainly through every handbook except that on the protection of Merchant Shipping, for instructions as to what to do. I understand that I shall not be allowed to use the head-lamps of my car in their present form, and that "a suitable masking device is being designed."¹ If this is done on country roads also, traffic will be enormously slowed down, and there will be many accidents. What about parking in the towns? In Madrid it was illegal to park a car with its lights on. What do I do during an air raid? In Barcelona one dives for the nearest shelter, leaving one's car in the street with the ignition key in place, so that it may be used by officials if necessary. In a narrow London street it might be best to drive abandoned cars onto the pavement to leave as much room as possible for fire engines.

Meanwhile I do not know if I shall be prosecuted for leaving my lights on, or for turning them out.² Possibly instructions are ready to be published in the

¹ A.R.P. leaflet on lighting restriction, February 14th, 1938.

² I had not guessed the answer to this question, since I altogether underestimated the ingenuity displayed by our bureaucrats in producing unworkable regulations. The answer is "Both." In reply to a question by Mr. Griffiths in the House of Commons, Mr. Lloyd stated on June 15th, 1938, "The arrangement contemplated is that the side and rear lamps of vehicles should be screened so that they are not visible from the air." Thus unless a motor vehicle is provided with

newspapers or broadcast when war threatens. But they will be carried out much more completely if we know about them in advance. Can it be that the authorities have not yet made their minds up?

I presume that all arrangements have been made for darkening trains, since this can be done directly through a few railway companies. But here again the public may have to co-operate. Even if the lights are dimmed we may have to keep the blinds down at night. And the more we can learn in advance about our duties the less confusion there will be should war come.

GAS-PROOF ROOMS

We are given rather full instructions as to the preparation of what is called a refuge-room for each house. It is supposed to afford fairly complete protection against gas, and partial protection against bomb splinters. We shall deal here with the question of gas-proofing. The adequacy of protection against incendiary and explosive bombs will be considered later.

The basement is regarded as the safest place, but any floor except the top may be used. An obvious remark, which Sir Samuel Hoare does not make, is that a room with only one external wall is safer both from gas and splinters than a room with two. Elaborate instructions for gas-proofing are given. Ventilators,

suitable screens of a design not yet disclosed it had better not be used at night. Just how such screens are to work is not clear. Even if the lamps do not shine directly upwards, how is an illuminated number-plate to be visible from the road, but not from the air?

keyholes and cracks in the wall or between the floorboards are to be filled with putty or sodden newspaper. The chimney is to be blocked with paper, rags, or sacks, and the front of the fireplace sealed with plywood and adhesive tape. Finally a blanket is to be nailed to the doorway, fastened with strips of wood; but the lower part of one side, and the bottom, are to be left loose so that a person can get in by stooping. This is clearly illustrated. During a raid the blanket should be wetted.

The windows must be specially protected against breakage by blast or splinters. We are recommended to gum transparent wrapping material inside the windows, though we are warned that the moisture-proof wrapping material used for food packets requires a special cellulose varnish to stick it on. Enterprising firms are already issuing rolls of suitable stuff.

For the benefit of those who cannot obtain these materials I would personally remark that in Madrid most large window-panes were strengthened by a criss-cross arrangement of stout paper strips pasted onto them. This seemed to give a good deal of protection against the blast from bombs falling some distance away. For those who can afford them the Government recommends a barricade of sandbags full of earth outside the window.

How far are these precautions effective? In 1937 a committee of the Cambridge Scientists' Anti-War Group published a book¹ in which it was stated that no ordinary room is anywhere near gas-proof. As I propose to criticize this book to some extent, I

¹ *The Protection of the Public from Aerial Attack.*

should like to begin by saying that in my opinion every fact recorded in it is entirely reliable, and that the experiments were well planned and carefully carried out. The method employed was to liberate carbon dioxide in a room, and to see how quickly it leaked out. This method was criticized by Mr. Geoffrey Lloyd M.P. in the House of Commons. After a false statement about the authors which would probably have been a slander had it been made outside Parliament, he went on to say, "These scientists did not measure the amount of gas which leaked into a room, but they measured the amount of gas which leaked out of a room, and then they tried to deduce by theoretical methods how much gas would have leaked into the room. I am advised by the Government's technical advisers that this procedure naturally led to important fallacies."

Let us examine this statement. The amount of gas which leaks into a room in a given time is exactly the same as the amount which leaks out, save for small corrections due to changes of temperature, pressure, and humidity, and small volume changes when oxygen is used up for breathing or burning. For suppose all the air in a room leaked out, and was replaced, not by the same amount of air, but by one per cent less, the pressure on the walls and windows would be increased by one hundredth of an atmosphere. The pressure on a 2 ft. \times 5 ft. window would be 216 lbs., or 15st. 6 lbs.

The abstruse and intricate theory which the Cambridge scientists used is embodied in such equations as: 20 cubic feet (inwards) = 20 cubic feet (outwards).

It would appear that such abstract reasoning is beyond the grasp of His Majesty's Ministers. I do not for one moment believe that the technical advisers of the Government had the faintest doubt as to the validity of these experiments. Mr. Lloyd doubtless went on the principle

"That is enough to satisfy the Senate," and apparently it was enough. But such an answer shows that the standard of veracity of Ministers on scientific matters has not improved since the Home Secretary, defending the Government for not preventing the importation of fat into Germany, informed the house during the Great War that the production of glycerine from fat was a recent discovery, whereas it was actually made in 1779. The Honourable Gentleman scored his point, and some thousands of British soldiers died, as some thousands of British civilians will die for a similar reason in a future war. In case this is construed as an attack on Parliamentary Government, I may add that things are at least as bad in Germany, and worse in Italy, where criticism is treason.

The rate at which air leaks out of (and therefore into) houses was first investigated by Pettenkofer¹ in 1858. Between 1897 and 1902 a large number of experiments were made by J. S. Haldane on this question, in connection with poisoning by lighting gas,² and the ventilation of factories and workshops.³ They were made with coal gas from burners and with

¹ *Ueber der Luftwechsel in Wohngebäuden* (Munich).

² *Report of Departmental Committee on carburetted water gas*, 1898.

³ *Report of Departmental Committee on Ventilation of Factories and Workshops*, 1902.

carbon dioxide produced by burning candles. The experiments were done in four ordinary rooms, two large rooms, a town hall, and a church.

If the candles were allowed to burn in a closed room the amount of carbon dioxide in the air gradually rose. But after a time which varied from under an hour to five hours it became steady, because as much was leaking out in a given time as was being formed. It was then easy to calculate the time in which a volume of air equal to that in the room leaked in.

This time was found to depend on many things. It was naturally less when there was a strong wind. It depended on the size of the room, being generally less when the room was small. For if the size of a room in each direction is doubled the surface is increased four times, but the volume of air eight times. It depended a good deal on the tightness of the walls, windows and doors. But the most important factor is the chimney. With a fire burning the time may be as low as twelve minutes. With the chimney open, but no fire, it was often less than an hour.

If the chimney was closed, even by metal flaps over the fireplace, the time was over two hours unless there was a considerable breeze. The most gas-tight room tested had no chimney, and the walls were partly of sandstone. The time here was four to five hours on a calm day.

These figures agree very well with those of the Cambridge Group. If my father had any bias, it was in favour of slow leakage, that is to say long times of air exchange, as he was writing in favour of better ventilation. The Cambridge Group, if they were

biased, were biased in the opposite direction. They should therefore have found shorter times. To make their observations comparable with J. S. Haldane's the times of half-leakage given by them must be multiplied by 1.46 (see Appendix III). When this is done they range from $3\frac{1}{2}$ to $13\frac{1}{2}$ hours. The greater length of time was probably due to choosing suitable rooms and gas-proofing them conscientiously. They point out, however, that in crowded areas efficient gas-proofing would be very difficult, and that many houses are in such a bad condition that they would leak severely. It is just these houses which are most overcrowded.

In England during most of the year houses are warmer than the outside air. In consequence the air in them tends to rise. If the chimneys are blocked it rises up the staircase and through the floors. This is particularly so in large buildings. "We noticed that as a general rule the air in basement or ground-floors is relatively pure. *Basement and ground-floors rooms commonly act as intakes for whole buildings.*"¹ In spite of this known fact we are recommended in Handbook I and *The Protection of Your Home* to use the basement as a refuge room. Poisoned air would leak in during a raid just as pure air leaks in normally.

"In all rooms a certain amount of exchange of air occurs through the walls, roof, floor, and various chinks, as was originally proved by Pettenkofer. *He showed experimentally that when all visible chinks were closed in a room investigated by him the rate of ventilation was only diminished by 28 per cent; as compared with the*

¹. J. S. Haldane, *Journal of Hygiene*, Vol. 2, p. 441.

rate when the windows and door were only closed in the ordinary way.”¹ J. S. Haldane confirmed Pettenkofer’s conclusion. In other words the elaborate precautions recommended would have very little effect, and may be regarded as “eyewash” designed to make people think that they are doing something valuable.

The Home Office officials apparently take the view that a room can be made gas-tight. For we are told “if you use candles do not burn more at a time than is necessary, to avoid using up oxygen.”² A man at rest uses about 0.7 of a cubic foot of oxygen per hour, and produces 0.6 of a cubic foot of carbon dioxide. Women and children breathe less. An ounce of candle uses about 2 cubic feet of oxygen. The most gas-tight room investigated by J. S. Haldane was 22 feet square and 11½ feet high. This would hold 24 people according to the handbook. The carbon dioxide percentage would have risen by 1.0 to 1.3 per cent, and the oxygen would have fallen by 1.5 to 1.2 per cent, which is absolutely imperceptible. At this level leakage would balance the effect of breathing. A few candles would make no real difference. The true facts are stated in Handbook I, namely that “the first trouble will not be shortage of oxygen or increase of carbon dioxide, but intolerable discomfort due to the rise of temperature and humidity of the air.”

Let us now examine the case against the Cambridge Scientists. It has been suggested by Sisson³ that gases would be adsorbed on their way through a brick wall. This seems unlikely in the case of phosgene, though

¹ *Report on Ventilation of Factories and Workshops*, 1902, p. 105.

² *The Protection of Your Home*, p. 23.

³ *On Guard Against Gas*.

It is to be noted that in the last experiment the "gas-proof" room was certainly not smoke-proof. Babies with no respirators would have suffered severely, though they would not have died, nor been ill for more than a few hours. But the effect on their mothers' morale may be imagined. On the other hand the amount of arsenical smoke used is said to have been large, and I think the Government is right in stating that "The conditions of these trials were . . . extremely severe, and represent a situation which would only rarely be met, and in which only a small number of houses would be involved."

Though I personally find these experiments reassuring, others may not. The following criticisms can be made.

1. The strength of the wind is not stated. The experiments might have had a different result during a dead calm. If an attack is made on London with non-persistent gas, it will probably be made during a winter night in calm foggy weather.
2. "The cottage, though unoccupied, was in a reasonable state of repair." The results might have been different had a house been used in the state of repair in which hundreds of thousands of families live.
3. As regards the chlorine experiment the comparison is misleading. The unprotected room had a fire burning. If the fire had been out and the chimney plugged, it would probably have leaked at about one-tenth of the rate, and it is possible that the men would not have needed respirators even had paper not been pasted over joints between boards and the like.
4. The experiments on the gas-protected room with

chlorine and mustard gas were done on "animals." We are not told what animals. And this makes a difference. For example rabbits are far harder to kill with mustard gas than cats, dogs, and monkeys. Men appear to be about as susceptible as the latter group. It is rather remarkable that if the "eminent experts not in Government employment" were completely confident in the gas-proof qualities of these rooms, none were prepared to stay in them without a respirator, or even with one in the case of mustard gas. During the Great War a number of experts, notably my father and Sir Joseph Barcroft, repeatedly risked their lives, and sustained a certain amount of injury, in experiments of this type.

5. One important experiment was not made. While it is true that the air in a house is usually warmer than that outside, this is not the case on a summer day. In consequence the air in the house tends to fall, instead of rising, as usual. Now it is just in warm weather that mustard liquid evaporates most rapidly, so that the concentration of mustard gas is highest. What would have happened if mustard gas had been sprayed on to the roof of the house on a summer day, as it might be from an aeroplane? Very possibly no harm would have been done; but I should like to know.

6. The most fundamental criticism of all is this. A gas attack on a town would probably be made after a number of houses had been shattered, and a much larger number had had their windows broken, by the blast and shock of high explosive bombs. In this case babies without respirators or protective bags would be killed. If this fact is forgotten the experiments are inevitably misleading.

DP

The object of these experiments was to reassure the public. I wish to make the following suggestion. A group of scientists, including if possible at least one member of the Cambridge Group, should be nominated by the various political parties in Parliament and permitted to carry out experiments of this type, with the assistance of the Chemical Defence Research Department. And one or two representatives of other bodies might attend. At least one person in the mustard gas experiment should not wear a respirator, in order to represent a baby. I should have no objection to being this person, as I have a fair degree of confidence in the chemical method for its estimation.

If this were done, one of two things would happen. Either the official claims would be confirmed, in which case the public would be reassured, and the danger of panic during a gas attack greatly lessened. I think this is the most probable outcome. Or alternatively it would be found that further measures are necessary. This would also be to the public advantage. I can see no possible argument against such a course from the official point of view, unless the Government has something to hide. And my personal opinion is that in this particular matter (and unfortunately only in this one) the Government has quite a strong case. Indeed if I were out to score every possible point against them I should certainly not make this suggestion.

PROTECTION FOR BABIES

Some of the possible types of protection for babies are described in Appendices II and IV. In December

1935, according to the *Daily Telegraph* of December 24th, Wing-Commander Hodsall, of the Home Office A.R.P. department, stated, "It is not impossible to make a respirator even for tiny babies, but, as mothers might object, we have something else for small children. I cannot tell you what it is at present, because it is an embryo state."

The embryo elephant takes about 18 months to develop. This was long believed to be a record. Wing-Commander Hodsall's embryo has now taken 30 months, and the gestation may be still further prolonged. Meanwhile our Government has started an inquiry into the causes of the falling birth-rate. One reason is undoubtedly that women do not want to bring children into the world in order to be suffocated.

The women voters of England have not done their duty in this matter. If they had made their opinions felt by making trouble for their Members of Parliament our babies would now be protected. When the suffragettes fought for the vote they believed that the women voters would see to such matters. This matter concerns every mother in England, and they have done nothing about it. If every M.P. had received a postcard a day on the matter for the last two years (which would have cost exactly £1,000) we should have protection for our children by now. Allowing three months for experiment and design, and another three for organizing factories, production could have been started about July 1936.

The apathy on this subject has been almost equally great in all parties. Too many of the women have allowed themselves to be interested in the various shows, from the coronation to the latest murder or fashionable wedding, which serve to divert their minds

from things that matter. I only hope that their children will not suffer for it.

Meanwhile we must be content with the fact that some sort of protection for babies is semi-officially said to be on the way. It must be remembered that when it is made it will be almost useless unless mothers and everyone else who may have to look after a baby at the critical moment, are trained in its use.

In particular the children themselves must be trained. A small baby may remain quiet in a bag or box with a window through which it can see its mother or some other person whom it trusts. But a vigorous child of two or three years old is a very much tougher problem. Unless it is trained beforehand it will struggle, and might even tear a hole in the bag with its teeth, or force a hand or foot through the window. It is not impossible to train children in the use of such devices. When I was acting as biochemist in the Infirmary at Edinburgh I found it much easier to get children than adult women to breathe through a mouthpiece with a clip over their noses. Indeed many of them enjoyed it. But the children will have to learn to get into bags in peace time, and not during the alarm and horror of an air raid.

Until the Government issues a bag, an alternative method is suggested in Appendix IV.

RESPIRATORS

Here we have to answer two distinct questions:

1. Are the civilian respirators satisfactory?
 2. Will they be properly used?
- In my opinion the second is the most vital.

I have myself no reasonable doubt that the civilian respirator can give full protection to the eyes and lungs against any gas or vapour which can be used by the enemy unless a large bomb bursts within a few yards of a man in the open, or in the same room with him. Even so he is in vastly less danger than from a high explosive bomb of the same weight, and any bomb-proof shelter will protect him from this peril also.

I am not quite so happy about smokes. The report just quoted states that a dense cloud of arsenical smoke (nature and amount not stated) was liberated. The civilian respirator protected men completely in an unprotected room, and also in the open when 200 yards down wind. I do not think it would have protected them at a distance of ten or even twenty yards. Had it done so we should have been told.

The Cambridge group¹ heated diphenyl-arsine-cyanide (amount not stated) in a room, and found that small amounts of it penetrated a respirator which appeared to be of the same make as the British Civilian Respirator. As however they were not able to get respirators from an official source, it may be claimed that the official pattern is better.

Tobacco smoke was also found to penetrate the civilian respirator rather easily. It has been pointed out with truth that a respirator permeable to tobacco smoke may keep out arsenical smokes, because the particle size is different. But new types of poisonous smoke may be produced with a different particle size from those yet known. It is noteworthy that the range of substances which can yield smokes is perhaps larger

¹ Fact, No. 13, p. 43.

than that which can yield vapours, and not so fully explored. An enemy power is therefore more likely to spring a surprise on us with smoke than with gas.

However, I recognize that as regards the respirator design the Government can make out quite a good case. And if and when they get respirators, the people of Britain will be better off than those of most other countries, except France. In France those who can afford them are to pay for respirators, the poor are to get them free, and the quality appears to be somewhat superior to the British as regards the filter. Nowhere else are respirators to be issued free to all who are thought likely to need them.

Our respirators are to be stored locally. Some stores, e.g. that at Hendon, are said to be complete. They are to be issued if and when the need arises.

The problem of storage and distribution of respirators is dealt with in a most interesting article¹ by the Chief Constable of Blackburn. The face-pieces and filters are stored in separate air-tight containers in a store whose temperature should, so far as possible, remain between 50° and 60° F. Cold is particularly harmful. In an emergency the containers have to be opened and the respirators put together. At Blackburn it is intended to obtain 76 women workers for this purpose from the Labour Exchange if enough volunteers are not available. It seems to me that it is much more important that volunteers should everywhere be available and trained for this vital task than for a number of others for which they are now being recruited.

The respirators at Blackburn will be assembled in

¹ "Fire Protection and Air Raid Precautions Review," May, 1938.

four stores holding 30,000 each, and then transported in 60 commandeered vans to 28 schools and halls which will be used as Distributing Depots, each serving about 4,000 people. From there they will be distributed by the Air Raid Wardens. Even with so well thought out a scheme the assembly and distribution would hardly, I think, be complete in a day. It is up to everyone who is afraid of gas to see that his or her own local authority has at least as efficient a scheme.

The policy of storage till the last moment has its advantages and disadvantages. Let us begin with the advantages.

1. The respirators will not be damaged or lost, as some of them certainly would be if they were issued to the general public.

2. They will be stored under better conditions, and will therefore deteriorate less quickly.

3. It is thought that if they were issued now this would give rise to the view that war is inevitable. I confess that the presence of a respirator in my cupboard would have less psychological effect on me than the constant drone of aeroplanes overhead actually has.

The arguments against storage till the last moment are serious.

1. A German attack would probably be a surprise attack. So at least the official Nazi newspapers state. Thus according to the *Angriff* of July 18th, 1937, "Declarations of War, like that which the German Chancellor von Bethmann-Hollweg made in August 1914, belong to a time which now seems like a survival of baroque diplomacy: for a long time now war has been entered into in a different way, without any words,

more secretly and even more cunningly; the creation of Manchukuo and the present operations in China are classic examples of the new method of extending the sphere of power." The Government may think that they will get warning. But on the day before the General Strike of 1926 a distinguished official of the Home Office (now a director of various companies) assured me that there would be no strike. Our authorities may have even worse information regarding the intentions of Herr Hitler than they had concerning those of Mr. J. H. Thomas.

2. In the event of a brief warning of only a few hours or even days the difficulties of issuing them might be too great. Either there would be huge queues outside the stores, or the air wardens would be entirely occupied in issuing them, when they might have other urgent duties, such as advice on various forms of protection.

3. In view of the failure of the Government to keep its promises in other respects, many people will be sceptical as to whether the respirators are actually stored in readiness for use, even after official announcements to this effect have been made.

These arguments perhaps balance those in favour of storage. I do not feel competent to decide between them, though I make a suggestion on p. 204. The real argument against the Government's anti-gas measures, which seems to me the most vital of all, and to have received hardly any serious attention, is as follows: The British respirator is the cheapest and simplest type in existence. So far as I know every other kind, whether for soldiers or civilians, which is issued in any country, has two valves, an inlet valve by which air enters through the filter, and which prevents the wearer

from breathing out again through the filter, and an outlet valve which allows the expired air to leave the mask, and prevents poisoned air from outside from leaking in. It is necessary that the expired air should not go out through the filter, for the charcoal can adsorb water vapour as well as poisonous gases, and when once it is wet it ceases to adsorb these latter.

In the British respirator, and no others, the expired air leaves, not through a valve, but between the wearer's cheeks and a flap of the respirator which rests against them. When he starts to inspire, the flaps are forced against his cheeks so that he cannot suck any air in between the cheek and the flap.

This is what is supposed to happen. It certainly does happen in the case of trained men or women, who have been properly fitted with respirators, and trained in their use. But it is equally certain that it does not always happen with untrained people. My wife recently went with a friend to the Air Raid Precautions Exhibition in Westminster. They were given respirators which were fitted by an expert, and went into a room full of tear-gas. Within two minutes she was weeping mildly, an activity to which she is not usually given. Her friend, whose respirator fitted still worse, had sore eyes for some hours after coming out.

Both the people concerned were at least as intelligent as the average of the population. And the man who "fitted" their respirators had considerable experience. The mass of the people are to be shown how to wear a respirator by an Air Raid Warden, who is regarded as suitable because the police consider him or her to be "of good character, level-headed, and free from obvious

physical or temperamental disability." These admirable qualities do not qualify one to fit a respirator onto a person whose cheeks have fallen in through loss of teeth, or who wears her hair in such a way as to favour leakage. The Air Raid Wardens receive a certain amount of anti-gas instruction. They doubtless know how to fit on their own respirators. But this does not necessarily qualify them to teach others.

That this is the view of at least some officials appears from an article in which the Chief Constable of Blackburn says that if the respirators are "to prove efficient and afford the complete protection claimed for them, it is necessary that not only should the correct size be allocated to each person, but the vital knowledge of how to fit and adjust the mask must also be imparted."¹

I believe that there is only one way in which we can ensure that respirators will be efficiently used, and that is to see that everyone in our great towns has an opportunity to try a respirator in an atmosphere of tear gas (chloracetophenone is the compound generally used). If this is done we may find that my wife's experience was quite exceptional (though her case does not stand alone). On the other hand it may be that quite a number of people cannot be adequately fitted. If so a more efficient type of respirator will be needed for them. This measure, if it were found that most people were protected, would have a great effect in allaying panic. For there is likely to be a great deal of terror, which might become uncontrollable, if the people of a large town realize that gas-protected rooms are not bomb-proof, and therefore take to

¹ *Fire Protection and Air Raid Precautions Review*, May 1938.

bomb-proof or partially bomb-proof shelters which are not gas-proof. There is at least one section of the population which might easily be taught the use of respirators, namely the school children. However, the Board of Education¹ discourages this on the ground that such instruction "might have adverse psychological or other effects on them or the general public."

Once more, I believe that the whole matter would be immensely clarified if an all-party committee of experts such as I have suggested, were appointed. I think that some of the criticisms of the Government precautions would prove unfounded. Others would probably turn out to be correct. If the civilian respirators are really proof against arsenical smokes the public should be reassured on this question. If an ordinary Air Raid Warden is adequately instructed in fitting them the public should learn this fact, which would greatly increase their confidence in the Air Raid Wardens. If this is not true, the necessary steps for our protection should be taken. Possibly we should all be supplied with a better type of respirator, such as the Civilian Duty Respirator. But the experience of experts, working with trained and disciplined men, probably soldiers, is no guide to what would happen with ordinary people, some of them rather stupid and rather frightened, but yet citizens who have a right to protection.

DECONTAMINATION

Non-persistent gases soon drift away or disperse into the air. Liquids with a poisonous vapour, i.e. so-called

¹ Circular 1461.

physical or temperamental disability." These admirable qualities do not qualify one to fit a respirator onto a person whose cheeks have fallen in through loss of teeth, or who wears her hair in such a way as to favour leakage. The Air Raid Wardens receive a certain amount of anti-gas instruction. They doubtless know how to fit on their own respirators. But this does not necessarily qualify them to teach others.

That this is the view of at least some officials appears from an article in which the Chief Constable of Blackburn says that if the respirators are "to prove efficient and afford the complete protection claimed for them, it is necessary that not only should the correct size be allocated to each person, but the vital knowledge of how to fit and adjust the mask must also be imparted."¹

I believe that there is only one way in which we can ensure that respirators will be efficiently used, and that is to see that everyone in our great towns has an opportunity to try a respirator in an atmosphere of tear gas (chloracetophenone is the compound generally used). If this is done we may find that my wife's experience was quite exceptional (though her case does not stand alone). On the other hand it may be that quite a number of people cannot be adequately fitted. If so a more efficient type of respirator will be needed for them. This measure, if it were found that most people were protected, would have a great effect in allaying panic. For there is likely to be a great deal of terror, which might become uncontrollable, if the people of a large town realize that gas-protected rooms are not bomb-proof, and therefore take to

¹ *Fire Protection and Air Raid Precautions Review*, May 1938.

bomb-proof or partially bomb-proof shelters which are not gas-proof. There is at least one section of the population which might easily be taught the use of respirators, namely the school children. However, the Board of Education¹ discourages this on the ground that such instruction "might have adverse psychological or other effects on them or the general public."

Once more, I believe that the whole matter would be immensely clarified if an all-party committee of experts such as I have suggested, were appointed. I think that some of the criticisms of the Government precautions would prove unfounded. Others would probably turn out to be correct. If the civilian respirators are really proof against arsenical smokes the public should be reassured on this question. If an ordinary Air Raid Warden is adequately instructed in fitting them the public should learn this fact, which would greatly increase their confidence in the Air Raid Wardens. If this is not true, the necessary steps for our protection should be taken. Possibly we should all be supplied with a better type of respirator, such as the Civilian Duty Respirator. But the experience of experts, working with trained and disciplined men, probably soldiers, is no guide to what would happen with ordinary people, some of them rather stupid and rather frightened, but yet citizens who have a right to protection.

DECONTAMINATION

Non-persistent gases soon drift away or disperse into the air. Liquids with a poisonous vapour, i.e. so-called

¹ Circular 1461.

persistent gases such as mustard "gas" and Lewisite, remain about for days or weeks. And so long as they remain they poison the air around them. In the country an area contaminated by the liquid could be fenced off. In a town it is necessary to get rid of the liquid.

Lewisite rapidly reacts with water, giving a somewhat poisonous liquid, but poisonous only when drunk, and no longer yielding a poisonous vapour. This reaction is a matter of minutes only, especially when the weather is warm. Indeed moist air would probably destroy the vapour fairly soon. Mustard gas also reacts with water, but its destruction takes hours or even days. On the other hand, it reacts very quickly with such oxidizing agents as chloride of lime (CaOCl_2). Indeed, the reaction between them is so violent that they may burst into flames, and to prevent this the Government recommends a mixture of chloride of lime with sand to decontaminate the pure liquid.

Decontamination is dealt with in A.R.P. Handbooks 1, 4 and 6 and Memorandum 3. About 6 squads of 6 men each are to be available per 100,000 inhabitants. And there will be additional squads in large factories and garages. Each squad will be equipped with a motor vehicle, old fire hose, 2 cwts. of chloride of lime, oilskin suits, and other necessities. Their main object is to destroy mustard liquid. Besides this they will put up yellow boards with black letters (a tribute to the Automobile Association) bearing the words,

DANGER

GAS

Streets will be washed down with a hose, and if the mustard liquid is present in large amounts it will be destroyed with a mixture of sand and chloride of lime, and in special cases covered up with earth. Buildings which have been splashed with mustard liquid will generally be treated with chloride of lime and water, and in certain cases washed either with water or petrol. Furniture is to be treated in different ways. In many cases it will be best to burn it. Vehicles must be hosed down, and then treated with chloride of lime if necessary, and upholstery generally burnt. Special instructions are given regarding factories.

Besides this, instructions are given for decontaminating clothing which has been splashed with mustard liquid or contaminated with its vapour. This is to be taken off as soon as possible, either at home or in a first aid post. Lightly contaminated clothes should be hung in the open air for at least 24 hours, though light dresses and underclothing may be washed with soap and water for 15 minutes. Heavily contaminated or splashed clothing requires treatment in a steam disinfecter, or boiling for at least an hour. Boots are to be treated with a paste of bleaching powder and vaseline.

I think that these precautions are admirably conceived and will be reasonably effective. But I think they will rather rarely be needed. And personally I shall not worry very greatly about the danger of being blistered when I am much more likely to be burned alive or blown to pieces.

One very strange feature of the regulations is that no tests are to be performed on members of the decontamination squads to see whether they are sensitive to

mustard gas. Marshall, Lynch, and Smith,¹ whilst working for the American Chemical Warfare Service, found that different individuals varied greatly. Those who had been burned already were much more susceptible. Fifty-five men who had never been exposed to mustard gas before were exposed to air saturated with the vapour at 20° C. The end of a test-tube containing the vapour was held against their arms. The average man needed 1 to 2 minutes to produce a burn. But one man reacted after 1 second, 8 within 15 seconds or less, while one white man and all the six coloured men tested required 10 minutes. Similar tests with the liquid on 1,713 other men completely confirmed their results, including the greater resistance of negroes.

It is therefore remarkable that, according to Handbook 3, "All persons are sensitive to the action of mustard gas, and so far as is known all who have not previously been exposed to its effects possess approximately the same degree of sensitivity irrespective of race or colour." Professor Marshall is one of the best known pharmacologists in the U.S.A., and his work is generally regarded as accurate. He may, of course, have been wrong, but the Medical Profession, to whom Handbook 3 is addressed, are accustomed to hear both sides of such questions. It would be desirable to tell them on how many men, and by whom, the experiments which refuted Professor Marshall were made. Until then, I for one shall be inclined to think there is something in Marshall's results. I shall regard coloured men, of whom there are plenty in London, as particularly suitable for decontamination work. And

¹ *Journ. of Pharmacol. and Exp. Therapeutics*, Vol. 12, p. 2911, 1919.

I shall consider the use of untested men as a dangerous and callous disregard of facts. Once more I may be wrong, and am perfectly willing to be convinced. But until I have some actual evidence to the contrary, I shall prefer that of my esteemed colleague, Professor Marshall.¹

In this chapter I have dealt in some detail with the problem of protection against gas, not because I consider it the most important aspect of the A.R.P. problem, but because it has received quite a disproportionate share of attention, first from sensation-mongers, then from the Government, and lastly from its critics. There are several reasons for this fact. The first German gas attacks in 1915 were very effective. They were possibly violations of international law, though not, I think, certainly so, as was the use of gas in shells and trench-mortar bombs. And they caused great suffering, though no greater than septic wounds from shells and bullets. They were written up as German atrocities, and hence produced a considerable psychological effect. People came to think of gas as in some way more terrible than other weapons.

This tendency was encouraged by the fact that scientifically uneducated people (e.g. most Cabinet Ministers) are very ignorant of the properties of gases, and will believe stories about them which they would not believe about solids or liquids. Hence the frequent press stories of terrible new gases. As an example of the

¹ In reply to a question by Mr. Griffith, in the House of Commons, Mr. Lloyd stated on June 13th, 1938, that Marshall's experiments "were carried out with comparatively high concentrations of gas." Actually some were carried out with a solution containing one part per thousand of the liquid. Mr. Lloyd refused to give any details of the experiments which are alleged to refute them.

complete gullibility of the press, a message from New York in 1937, reprinted in newspapers of as different political complexions as *Reynolds' News* and the *Evening News*, was to the following effect. A new gas called acetyl-choline had been discovered, of which a very small quantity would render millions of people unconscious. Actually acetyl-choline is a crystalline solid discovered in 1876, which is no doubt rather poisonous when injected in sufficient amounts, but with which hundreds of physiologists have worked without taking any special precautions and without hurting themselves! Among those who spread these stories were a certain number of pacifists, some of whom, such as Mr. Beverley Nichols, I have since come out as admirers of Hitler. Doubtless their motives were excellent, but they did their country a bad turn.

For millions of people were led to suppose that gas was the principal danger in a future aerial war. It is, of course, a real danger, and for the last eight years I have from time to time demanded a supply of respirators; but it is a subsidiary danger. The Government very properly yielded to the general demand for respirators; and we have got a measure of protection against gas, or will have when our respirators are ready.

No reader of this chapter will suppose that I am wholly satisfied by what has been done. Nevertheless gas is the one kind of danger from the air against which we have at least a partial protection. Some kind of answer is available to almost every criticism. I can only wish that the same were true when we come to consider other dangers.

CHAPTER V

FURTHER GOVERNMENT SCHEMES

FIRE PROTECTION

INCENDIARY BOMBS HAVE, as we saw, been a failure (from the fascist point of view) in Spain. It does not follow that they would be a failure if used against special targets, such as oil tanks, docks, or certain types of factory. Indeed, I shall be very much surprised if they are not used against the London Docks. And if so, residential areas near the docks will be more likely to be attacked with them than those in other neighbourhoods.

As a preliminary measure we are told, when we receive official warning that war threatens, to clear the top floor of all inflammable objects. This is easy if one has a large house. It is impossible if one lives in one or two rooms on the top floor. The same is to be done in factories wherever possible. Woodwork in the attic or roof space is to be coated with lime-wash (2 lbs. of slaked lime and 1 oz. of salt with a pint of cold water). This will delay its catching fire.

Besides this we are to keep all baths, spare buckets, cans, and basins filled with water for the duration of the war, and on an upper floor we are to have a box of dry sand, foamed slag, or earth, and a shovel with a long handle. Better still are a Stirrup hand pump with thirty feet of hose, which is used to pump water

from a bucket, and a Redhill sand container with a metal scoop and a long handle. It is said that with this implement a small incendiary bomb can be picked up.

Or so we are told in *The Protection of your Home*. But Handbook 6, on factory protection, states that "When approaching an incendiary bomb, efficient dark glasses must be worn." They are apparently necessary for factory workers, but not for householders!¹ It is nowhere pointed out that besides thermite bombs, phosphorus bombs may be used, which shoot out burning phosphorus for many feet, and are quite unapproachable while burning, though less efficient than thermite in starting fires.

Water must not be used on the bomb itself, but may be used if once a fire has started. Reserves of water are particularly needed because water mains may be burst by explosive bombs, or the pressure may fall because a number of fires are being fought at once. Instructions are given for the organization of fire-fighting parties in factories, which are to be on duty day and night.

¹ In reply to a question by Mr. T. Smith in the House of Commons, Mr. Lloyd said, "The experience gained since Air-Raid Precautions Handbook No. 6 was published has shown that dark glasses are not necessary, as was formerly thought to be the case, in dealing with incendiary bombs. Subsequent publications have therefore omitted this instruction, and the next edition of the handbook will be amended accordingly." This answer throws a light on the efficiency with which the experiments on the extinguishing of incendiary bombs must have been conducted. One would have supposed that the thing would have been done thoroughly, and the necessity or otherwise of dark glasses determined before a handbook was issued. This was clearly not the case. I may add that I should not care to approach a 35 lb. thermite bomb without dark glasses, and that I disagree strongly with the view that they are unnecessary.

Now hand pumps, sand containers and the like will cost money. If I risk my life in putting out a bomb which would otherwise burn down my landlord's house, I think he might stand the cost of the fire extinguisher. Personally I have some fairly valuable furniture, and may be prepared to stand the cost myself. But most of my neighbours cannot possibly afford the money. So in practice unless fire extinguishers are provided by the landlord in low-rented houses they will not be provided at all. Unless therefore all this fire protection is "eyewash" or the Government is not interested in the lives of the poor, the provision of extinguishers should be made a statutory duty of the landlords or possibly of the municipal or national Government.

However, the main task of dealing with serious fires will fall on the fire-brigades.¹ Their personnel will be augmented by reservists with fire-brigade experience, and by volunteer auxiliary firemen. More heavy fire-fighting appliances of the usual type are to be bought. And a service of light fire-fighting appliances, such as trailer pumps, to be towed behind large cars or light vans, and portable pumps to be carried by vans, is to be started. Auxiliary fire-stations will be needed. All this is excellent, if it is properly carried out; and I believe that in a few towns a good deal of progress has already been made.

There is also to be a system of fire-patrols, which will keep every street under frequent observation, "if possible during the progress of a raid, but in any case immediately the attack is over." They are to use

¹ A.R.P. Memorandum 7, and Memorandum on Emergency Fire Brigade Organization.

cars or light vans. And watching posts are to be established to look out for outbreaks of fire in places where the street patrols might miss them. In the *Protection of your Home* we are also told that "If the house is a large one it would be a good thing for someone to stay outside the refuge-room, on an upper floor or in a trench or dug-out outside, as a watcher in case an incendiary bomb falls on the house or on a neighbouring building."

The memorandum in question was issued in 1937, and this section is criminally unrealistic. At the time when it was published incendiary bombs had already been proved a secondary menace to Madrid, and their use had been abandoned. It is perfectly clear that the main danger, except conceivably to special areas such as the docks, is the explosive bomb. If men are sent out to patrol the streets on the off-chance of a fire, they will be killed in very large numbers by splinters and blast from explosive bombs.

They will run risks enough, in all conscience, when actually dealing with fires. For a fire is an excellent mark for bombers, and even a light bomb bursting in the street may kill a number of firemen. This happened on at least one occasion in Madrid. In the same way anyone who is in a position to watch for fires is also in a position to be hit by splinters or British shrapnel. There is no mention, in the list of equipment, of shrapnel-proof helmets for these unfortunate men, though they are to be furnished with dark glasses. How a watcher is to watch from a dug-out is not clear to me.

I am quite convinced that this part of the memorandum was written without regard to facts which were

within the knowledge of the authorities, and that it is calculated to expose brave and useful men to a wholly unnecessary risk. If this policy is persisted in until a few patrols have been blown to pieces, the Government will be directly responsible for their deaths.

PROTECTION AGAINST HIGH EXPLOSIVE BOMBS

I have a rather pathetic little pamphlet¹ issued by the Catalonian Ministry of Propaganda and Council of Military Medicine in 1937, with the aid of the Catalonian Academy of Medical Sciences. I was given it in Barcelona in 1937, before the great air raids. It deals in detail with the gas-proofing of rooms, and tells how to clear inflammable materials out of attics, and to fight fires with sand and water. There are delightfully amusing pictures of the sensible family knitting and reading during a gas raid, and the stupid family looking out of the window and being poisoned. Above all the population is exhorted to keep calm. When I read it I thought some paragraphs had a familiar air. They had. They were taken almost directly from the British Handbooks.

I do not believe that the precautions suggested in the book, except possibly the suggestion that ferro-concrete buildings are safer than others, saved a single life when the raids came. On the contrary, it may have had the opposite effect. The people kept admirably cool during the first few raids. But when they found

¹ "Ciutadà: Què has de fer davant la guerra aèria?" Comissariat de propaganda de la Generalitat de Catalunya.

that the precautions suggested in this handbook were useless, there was a good deal more panic than might otherwise have been the case. If every precaution so far dealt with in this and the last chapter had been in force in Barcelona, two or three fires might have been put out, and a dozen or so at most out of several thousand lives might have been saved. The people of Barcelona were killed by high explosives. What protection have the people of London against this peril?

The Protection of your Home devotes two pages to the question of "How to prepare your refuge-room against the effect of explosive bombs." Another two pages are devoted to "Extra precautions against explosive bombs." They are not very encouraging. "It is not very easy to prevent the glass of closed windows being shattered by the blast of an explosion, even at some distance away." "Do not rely on a wall keeping out splinters unless it is more than a foot thick." So the windows are to be protected from blast in the manner stated on page 88, and if possible both the walls and above all the windows are to be protected by walls made of sandbags or boxes of earth 2 ft. 6 ins. thick.

But in practice people in houses are rarely killed by splinters which penetrate the walls. They are killed because the house is knocked down. It is suggested that the refuge-room should be strengthened against the collapse of its ceiling by stout upright wooden posts supporting a stout piece of timber against the ceiling, at right angles to the joists. In a very small percentage of cases this might just make the difference, and support a ceiling which would otherwise come

down. But it would be quite useless if the house were knocked over.

On page 18 is a list of "Things to have in your refuge-room." They include furniture, food, drink, toilet requisites, first aid supplies, books, cards and toys, and a radio set or gramophone, not to mention fire-fighting appliances. But the list does not include the one thing which is considered important in the cellars which are used as refuges in Spanish towns where there are no adequate bomb-proof shelters. This is a pickaxe with which people can hack their way out if the house collapses above them without crushing in the cellar. The official handbook does not distinguish very sharply between an air raid and a picnic. In Spain the distinction is quite obvious.

The one piece of information which is likely to be of value to the ordinary householder, in the sense of possibly saving his life, is given on page 30 of *The Protection of your Home*. After devoting most of the rest of the book to refuge-rooms, the author or authors suddenly had a spasm of common sense, and wrote a whole paragraph on trenches. "Instead of having a refuge-room in your house, you can, if you have a garden, build a dug-out or a trench." Nothing is said about dug-outs, and rightly so. Amateur dug-outs are not so safe as trenches. We are told to keep the trench "away from the house," (though not how far away) in order "to avoid falling débris," presumably débris of the refuge-room and those who have taken refuge there. We are told to provide head cover over a part of the trench. A foot of earth spread over corrugated iron, or even boards, will do. We are not told

whether the trench is to be straight or crooked, though we are very properly told that there should be a sump into which water may drain. Every old soldier would prefer to have his feet wet in a crooked trench during a bombardment rather than to have his feet dry in a straight one.

We are further warned that a trench is not gas-proof so "anyone using a trench or dug-out must, without fail, have his respirator with him." Hence the baby will presumably be left in the gas-protected refuge-room whilst the rest of the family take refuge in the trench! No mention is made of the fact that a dug-out can certainly, and a covered trench probably, be made as gas-proof as a great many rooms. We shall see later on that trenches offer a protection against explosive bombs far better, not only than houses, but than many highly expensive types of shelter.

A good deal more information is given in Handbook 6 as to protection of the personnel in factories and business premises against explosive bombs. But some of it is beautifully vague. "In general it may be said that within 50 feet of the explosion a building must be of substantial construction if it is to withstand the blast of a medium or heavy-weight bomb." In the case of a heavy-weight bomb, fifty yards would be nearer the truth. It is hard to say what is meant by "substantial construction," but by the standards of a factory, I do not think that any ordinary brick dwelling house can be said to be substantially constructed. The instructions as to protecting windows and thin walls in factories are similar to those given for houses.

However, here two much more satisfactory types of

shelter are recommended, namely trenches and galleries. In this handbook we are vouchsafed the information that trenches should be 7 feet deep, and that they should be revetted, that is to say lined with boarding, corrugated iron, or other suitable material. The head-cover should consist of two feet of earth, as compared with one for mere house-holders, and 9 inches or 12 inches of rubble, if available, should be placed on top of the earth. Along the trench seats 18 ins. wide are placed in recesses. A specification is also given for chambers in which six people can sleep in bunks, and double gas curtains, ramps, and the like are described.

On page 54 there is a fairly elaborate plan of a trench system, in which every trench is shown absolutely straight, some of them being at least 200 feet long. In case anyone should take such a plan seriously, a note is added, "These trenches are shown long and straight for diagrammatic purposes. In practice they will be better zig-zagged." This note is characteristic of the utterly irresponsible and amateurish way in which the whole book is written. The result is that we are nowhere told, what every old soldier knows, that the straight sections of trench should be as short as possible, say 15 feet as a maximum, since if even a light bomb bursts in a straight section of trench, everyone in the section is likely to be killed by splinters or blast. Perhaps in the next edition we may be favoured with a picture of a negro whose hair is "shown long and straight for diagrammatic purposes," using this trench system.

Another type of shelter recommended for factories is the gallery. Again the description is utterly vague.

"Provided there is sufficient earth overhead, galleries afford very good protection for personnel during air raids," Appendix I begins. But nowhere are we told how much earth is sufficient. A casual reader might suggest three feet. The actual quantity required is about 60 feet. The gallery is to be made of steel frames which form an arched gallery, with chambers at the sides.

In the diagram given in the handbook (Fig. 9) the galleries are shown as straight, and over 100 feet long. The chambers are simply recesses at their sides. This means that if a heavy bomb actually burst in one of the galleries, everyone in the gallery or the chambers off it would be killed. To prevent the penetration of a heavy bomb before bursting would need at least six, and probably twelve or more, feet of earth above the gallery. Of course even at this depth the gallery could very easily be crushed in by the shock of a large or even medium bomb. But unless the bomb burst inside only a few people would be killed.

I have no doubt that if such galleries are made under less than fifteen feet of earth they should be zig-zagged to localize blast effects so far as possible. One very bright idea in Appendix I is that these steel frames should be erected at ground level, and then covered by slag or waste, in the case of coal mines, tin mines, and other "undertakings where large slag heaps or waste dumps are formed." No information is given as to how great a weight of earth or slag such a frame will support. Nor has the ingenious author considered the fact that colliery waste dumps commonly heat up and often catch alight. This is well known to the

unfortunate inhabitants of Fife whose cottages happen to be near a "burning bing." It appears to have escaped the notice of the gentlemen in Whitehall. The burning bings, by the way, will be useful guides to enemy aircraft during night raids.

As a final note, nothing whatever is said about the gas-proofing or ventilation of such galleries. Unlike a room in a house, they could be made substantially gas-proof, and therefore might require ventilation, though this is not necessarily the case if the space per person were large enough, and the time of occupation small enough.

Besides this, in the fullness of time, either before or after the outbreak of war, we may expect the publication of A.R.P. Handbook 5, "Structural Precautions against Bombs and Gas." This has not yet come out, although Handbooks 6 and 7 had already appeared in 1937.

Meanwhile the unfortunate local authorities are enjoined in Paragraph 12 of their Air Raid General Precautions Scheme, to draw up a plan for "Provision of Shelters for the Protection of the Public" in accordance with a covering circular which is not named, but appears to be the one dated March 28th, 1938. Here it is stated that "it can be said that in most areas a large amount of accommodation will be found to be available which, by adaptation and strengthening and by the use of sandbags, could be made to give reasonable protection." Of course it can be said. But it cannot be said with truth.

We shall see in Chapter VIII that it is entirely possible to provide complete protection from explosive

bombs, and in Chapter IX we shall try to determine the reasons why this is not being afforded at present.

DISPERSAL

Throughout the Government publications there is an assumption that it is better to have people scattered over a vulnerable area rather than concentrated at one point of it. This comes out particularly in the Board of Education's Circular 1461 on Air Raid Precautions in Schools. In densely populated areas the schools are to be shut, and the children are to stay at home. It is quite rightly pointed out that the warning of an air raid would be insufficient to allow of their being sent home from school, and that they would be in great danger in the streets.

But the town schools are not to be protected, and as for the children "the primary importance of their safety will demand that they should be kept at home to share in the protective arrangements designed for the general public." In other words no public money will be spent on the protection of school children. And if their parents cannot afford to protect them, the Government will "deplore" their deaths, as it deplores the deaths of Spanish children.

As regards gas, it will be much easier to provide gas-proof rooms in public than in private buildings. Schools are also seldom over two storeys high, so the fire risk will be greater at home than at school. And in their homes there will be no bomb-proof shelters, whereas these could be made at the schools, particularly in the playgrounds. The argument, however, is that

"it would be unjustifiable to collect children in large numbers in schools." Undoubtedly a bomb falling on a school might kill several hundred children, and it is argued that they would be in less danger if dispersed. This is absolutely untrue. Dispersal within a dangerous area does not reduce the probable number of casualties. Whilst ensuring that no single bomb will wipe out a hundred people in a fraction of a second, it also ensures that almost every bomb will find a human target of some kind.

An individual child will be no safer, probably less safe, at home than at school. That is to say, dispersal will not reduce the average number killed in an air raid. It may be that the psychological effect of having 10 children killed in each of 20 towns will be less than that of having 200 killed in one. I do not pretend to know. But the actual probability of your child being killed will not be lessened in any way by shifting it from one place to another within a dangerous area.

In spite of this the Home Secretary continues to preach the policy of dispersal, and Members of Parliament continue to believe in it. I can write with some authority on the fallacy involved, as I have done a good deal of work upon statistics and the theory of probability. Here are Sir Samuel Hoare's words:¹

"Thirdly, they should remember that it always had been and still was, the view of the Government that the policy of dispersal was a safer policy than one of concentration of large numbers of the population into certain given spots (cheers). . . . As our policy is a policy of dispersal, that is to say, that citizens so far

¹ *Times*, June 2nd, 1938.

as they can should remain in their own houses, if there are to be shelters these shelters should be carefully sited and prepared in the right places." The logic of this latter sentence is interesting. We are led, I think, to suppose that if the policy were not one of dispersal the shelters should be carelessly sited and prepared in the wrong places. If not, what on earth does the sentence mean? I think it means that if you refuse to think clearly about dispersal you are unable to think clearly about other related problems.

Dispersal of this kind is something quite different from evacuation, that is to say removal of population to areas which are considered safer. Every attempt is made by speakers on behalf of the Government whom I have heard, to confuse the two. So I propose to quote at some length the relevant passage in the Home Office circular of March 28th, 1938.

"After careful consideration of all factors His Majesty's Government has reached the conclusion that the wisest policy is to aim at the dispersal of the population. Generally speaking, therefore, persons who, at the time of an air raid, are either in their own homes or in other buildings should remain there. With the advice and instruction that local authorities will be giving on air raid precautions, it must be assumed that householders will generally do what they can to increase the natural protection of their own homes, and that employers with business premises will not only ensure that their employees are properly instructed in the action to be taken in the event of an air raid, but will have made arrangements for such protection and shelter in their business premises as may be practicable."

His Majesty's Government know as well as anyone else that the vast majority of householders have done and can do nothing to make their houses bomb-proof. This paragraph is simply a statement that the Government do not propose to do anything for us. The last sentence is painfully reminiscent of Mr. Eden's statement that he intended to keep the League Covenant "so far as practicable," i.e. when it suited him to do so. We shall see later on what measures are practicable.

THE NON-MEDICAL AIR-RAID SERVICES

These consist of the following:

1. Air Raid Wardens.
2. Extra police.
3. Rescue parties.
4. Decontamination squads (see p. 107).
5. Extra firemen (see p. 115).
6. Staffs and messengers of report centres.

The Air Raid Wardens are supposed¹ to be leaders and advisers of their neighbours in a small area where each is known and respected. Their main duty in peace time is the fitting of respirators. On the "threat of war" they are to see to the distribution of respirators. It is stated that their war duties "would not commence until air attack began, by which time respirators should have been distributed." They should have been distributed. It is also true that towns should not be bombed, and gas should not be used. Further, no war-like measures should be taken without declaring

¹ A.R.P. Memorandum 4.

war; and finally, war should not be declared at all under the Kellogg pact. As however fascist powers have broken all these regulations, I can see no very good reason to suppose that they will be kept in the event of an attack on Britain.

When war begins their duties are as follows:

1. "To shepherd members of the public to shelter when an air-raid warning is received."
2. To give information to the proper quarters as to explosions, gas, fires, and damage to water and gas mains, etc.
3. To guide rescue parties, etc., to the scene of damage.
4. To help with fire-fighting and first-aid.
5. To help occupants of damaged buildings to new shelter.
6. To assist in every possible way to prevent panic, particularly by setting an example of coolness to their neighbours.

For this purpose they will be assigned posts, approximately one per 500 citizens, from which they will keep a look-out.

They are volunteers, but must meet with the approval of the police or other authorities. In Spain they are elected by their neighbours, but then Spain is a democracy. They will be armed with legal powers at present undefined, probably including the right of entering houses, but not that of arrest.

I do not envy them their position. Unless their observation posts are adequately protected they will be exposed to British shrapnel as well as enemy bombs, and though they will get civilian duty respirators as

well as badges, I have found no evidence that they will even get steel helmets. It took nearly two years of agitation before these were issued to the British infantry in the late war. I trust that the Air Raid Wardens will get them sooner.

But apart from this they will be in a very awkward position. They will doubtless do their best to reassure people, and they will possibly succeed during the first few raids. But when people realize that ordinary houses offer no serious protection against bombardment the wardens will inevitably lose any prestige which they may possess. People will start occupying solid buildings and trying to rush tube stations, as they did in 1917. It will be difficult to distinguish between panic and a display of common sense. The air-raid wardens are being given a duty which may well prove impossible, and for this reason many people are refusing to become wardens.

I think this is a mistake. We must do what we can to protect one another. But some Air Raid Wardens actually believe much of the propaganda which is being put over in lectures along with quite genuine accounts of gas, incendiary bombs, and so on. They are adopting a tone with their neighbours which democratically elected officials would hardly do. It is perfectly clear that after a single air raid such people will lose any authority which they may now possess with their neighbours.

It is stated in some quarters that the Raid Wardens, of whom there are to be about a million in the country, will be used as an organization for bullying the people in various ways. This is quite possible. If so it is also perfectly possible that some of the fury which in Spain

was directed against the fascists after air raids, and which led to some of the very few murders of innocent people which occurred on the Government side, may be turned against the Raid Wardens in this country.

But those Raid Wardens, and I believe they are the majority, who will recognize that they are being given an impossible task, yet attempt patriotically to carry it out, will have nothing of this kind to fear, and may be able to do something to save life in air raids. The Air Raid Warden who at the present time adopts the rather cynical attitude of saying "this is what we are told officially" is vastly more likely to retain the confidence of his neighbour in war time than the one who tells them that all necessary measures are being taken. He is also more likely to keep his own head if air raids do not happen according to the little yellow books.

The extra police will also be needed, particularly if evacuation schemes actually mature. But no amount of police will be of much value in keeping order if the people of any of our great towns are once persuaded that they have been deceived, and to a large extent wilfully deceived, as to the measures taken for their security.

Rescue parties of 6 to 8 men are to be organized on the very meagre scale of 6 parties per 100,000 population in an urban area. As several hundred bombs have been dropped in a single raid on a Spanish town of under 100,000 inhabitants, they are liable to be grossly overworked. They are to be drawn from workers in the building trades under local authorities or contractors. If, as in Spain, they are organized through the Trade Unions, this is likely to add to their efficiency. But even so I consider that they are far too

few in numbers. Their numbers will be equal to those of the decontamination squads. Now mustard gas has not yet been used in Spain or China. It is at least possible that it will not be used here. On the other hand high explosive bombs certainly will be if war occurs. Actually the same men will, to a large extent, be used for both duties.¹ It is not clear which will take precedence if mustard liquid is dropped after an attack with high explosive bombs.

Of course the need for rescue parties would be very much less in a residential area where few houses are more than two storeys high than in an area of high buildings and narrow streets. In an area of this latter type the number of parties per 100,000 is far too small. A party may take several days in looking for victims in a single wrecked building. So for maximum efficiency 3 parties working in shifts may be needed for one moderately large building. Hence the proposed scale of organization would suffice to deal with 2 out of perhaps 100 wrecked buildings after a severe air raid.

The plans for report centres² with their personnel and messengers are given in great detail. We even have blank message forms and instructions as to the colours of pins to be stuck on the map where a bomb falls—pale blue for explosive, red for incendiary, yellow for gas. This is the kind of administrative problem which our permanent officials can tackle, and have tackled, very well. But when I compare it with other parts of the A.R.P. schemes I cannot altogether resist making the deduction that the Civil Service considers it at least as important that the numbers of men, women

¹ A.R.P. Memorandum 7.

² A.R.P. Memoranda 2 and 6.

and children killed, injured and missing, should be recorded on the proper form, as that efforts should be made to dig out the missing as quickly as possible.

In addition to these services, men will be required¹ for the repair of roads, water pipes, gas pipes, electric cables, telephones, and sewers. The existing personnel will probably be insufficient. I can find no detailed account of what, if anything, is proposed regarding the recruiting of men for this purpose.

MEDICAL SERVICES²

These include first aid parties, ambulance services, and the staffs of first aid posts. The first aid posts are to serve casualty clearing hospitals and these are to evacuate patients to base hospitals which will mostly be in rural areas.

The first aid parties are to consist of 12-15 parties of 4 men per 100,000 population, with 25 per cent reserve in towns. To each party are attached two ambulances and a car for sitting cases, with one or two women drivers each, and one or two women ambulance attendants, say 7 women in all. These ambulances will take wounded directly to the first aid posts, or to casualty clearing hospitals if these are nearer. Serious and urgent cases (but not for example ordinary fractures or burns) are to be taken to the clearing hospitals at once.

The first aid posts will be divided into two sections, one to deal with unwounded persons whose skin or clothes have been contaminated with mustard liquid,

¹ A.R.P. Memoranda 2 and 6.

² A.R.P. Handbooks 1 and 7, and Circulars of Dec. 10th, 1937, and April 20th, 1938.

mustard gas, or Lewisite. Special arrangements are made for dealing with people who are both wounded and contaminated. The sexes are to be kept apart. Plans are given. A large post would serve 50,000 people or so, and could deal with about 50 wounded patients and 75 contaminated patients at a time. There would be a waiting-room for another 36. The staff of a large post will consist of four officers, presumably doctors, 32 fully trained personnel, and about 75 others, besides domestic staff.

The casualty clearing hospital will be a local hospital from which all ordinary patients who can be moved with safety have been removed "by evacuation to outlying hospitals, existing or improvised," and during war the casualties from air raids will be removed to base hospitals as quickly as possible.

The base hospitals will be places in rural areas normally used for other purposes, but not too far away to create a serious transport problem. For example mental hospitals, public assistance institutions, and possibly infectious diseases hospitals may be commandeered. In some cases it is admitted that it will be necessary to use the same hospital both as a clearing and a base hospital.

This scheme looks fairly good on paper. Actually in my own Borough of St. Pancras it is not yet (June 1938) known which hospital will be used as a casualty clearing hospital, although the memorandum on the subject was issued in September 1936. This does not surprise me. The taking over of a hospital involves a very complete dislocation of its ordinary work. It means that certain people who would otherwise be cured of disease will die. No hospital committee wants this to happen in their own hospital. The hospitals are

largely on a voluntary basis, but the State expects them to conform to its wishes as for example profit-making firms are not expected to conform. So long as hospitals are not paid for by the community we shall never have an adequate hospital system. Perhaps the knowledge that there will be nowhere to take many wounded people in the event of an air raid may make us realize its present inadequacy. In the same way the greater part, at least, of the personnel of the casualty services is (or was¹) intended to be provided by the St. John Ambulance Brigade and the British Red Cross Society. As these are voluntary organizations it is inevitable that they will function well in some areas but badly in others.

How far the schemes for medical services have gone is uncertain. In a few areas a good deal of progress has been made, in others much less. Many people, at any rate, will consider them far more important than the widely advertised schemes for air wardens. Personally I can dispense with the services of my local warden, as I know more than he about air raids. I cannot dispense with an ambulance, a dresser, and a surgeon, if I am hit. So I consider the poor progress of the medical service schemes in many districts as one of the most serious defects in the Government's performance.

The above is an analysis of the schemes at present officially sanctioned. Since I wrote it it has been officially acknowledged that these schemes have completely broken down. Sir Samuel Hoare said:²

"As hon. members are aware, the Ministry of Health has recently undertaken a survey of the hospital accommodation of the country with a view to air raid

¹ A.R.P. circular of June 23rd, 1936.

² *Times*, June 2nd, 1938.

precautions. Although that survey is not entirely complete it has, at any rate, led us to some provisional conclusions. It has tended to show us that the old distinction that we attempted to draw between casualty hospitals and base hospitals cannot, in the conditions of air raid, be fully maintained, and to show us that in the organization of the hospital system in air raid precautions the Ministry of Health, with all its expert knowledge and expert personnel, should be the responsible department." In other words the Home Office scheme will not work, and the Home Secretary would like to hand the baby to a colleague.

"It has been suggested in this connexion that casualty hospitals ought to be formed in the periphery of London on the lines of the tented hospitals in Étaples. Those casualty hospitals would be outside the main front of an air attack." Why? A study of the records of the British Red Cross Unit in Abyssinia would have convinced any ordinary person that tented hospitals are favourite targets for fascist aeroplanes. The miserable patients in them have no protection whatever against splinters or machine-gun bullets, let alone blast or gas. And tents form most conspicuous targets from the air. The Home Secretary's refusal to admit the plain facts as to fascist methods of war in Abyssinia and Spain leads him to propose the exposure of British wounded to the gravest danger.

Another proposal is that the colleges of Oxford and Cambridge Universities should be used. These buildings, though strongly built, are singularly unsuited for hospitals. They consist largely of small two-roomed flats on rather narrow staircases, and it is frequently

necessary to walk for some distance in the open in order to find sanitary accommodation. Besides which Cambridge, and to a less extent, Oxford, are very probable targets for raiders. The moral effect of wiping out either might be considerable.

However that may be, it is interesting to know the opinion of the responsible minister that, if war breaks out in the immediate future, the medical services are unprepared.

EVACUATION

As we saw in the last chapter, the Government fully recognize the desirability of evacuation for those who can afford it. In the skeleton air-raid scheme issued to County Boroughs,¹ page 16 reads as follows:

"Paragraph 16

Transfer of the Civil Population.

(To be completed as and when further directions are given by the Secretary of State.)"

The accompanying circular² states that "no single or comprehensive plan for evacuation is practicable. If the necessity arose for evacuation on any large scale, it would be carried out in co-operation between the Government and the local authorities. The matter is under examination by the Department who will be able, at a later date, to arrange for the subject to be considered in co-operation with the authorities who may be concerned."

This statement is untrue. If the necessity for large

¹ S.O. Code No. 34-9994, for 1938.

² A.R.P. circular, March 28th, 1938.

scale evacuation arose next week, it would be carried out, not by the Government or any other authority, but by millions of terror-stricken individuals blocking the railway stations, congesting the roads, and dying by hundreds, even if they were not attacked from the air, of accident, disease, fatigue, and even starvation. This is what has happened in Spain and China. It is pleasant to think that, at a later date, the whole question will be considered. No promise is, however, made that anything will be done about it. Meanwhile I understand that a committee is discussing the general line of policy to be adopted.

SUMMARY

We have now surveyed the Government's schemes. None of them is complete, except perhaps the scheme for respirators in a few areas. If marks could be allocated on a percentage basis, I should be inclined to do so as follows. The basis of the mark is the percentage reduction in deaths to be expected as the result of the Government's schemes (a) in so far as now carried out, (b) if the schemes at present on paper were actually in force. A perfect scheme would score 100. E.g. a perfect casualty scheme would ensure that no wounded would have to wait for longer than is absolutely unavoidable before being properly treated.

	(a)	(b)
Black-out schemes	50	70
Protection against gas	30	80
" " fire	40	60
" " high explosives	-20	40
Evacuation	5	5
Medical schemes	30	80

The negative figure for protection against high explosives is reached as follows. I believe that the emphasis on the gas danger will lead people to stay in their houses in many cases where they might have dug a trench, and will therefore actually increase the casualties from high explosive bombardment over those which would have occurred had the newspapers been allowed to give a full and truthful account of events in Spain, and methods there adopted, on which the public might have acted.

It must be remembered that considerable and effective pressure has been brought by the Government upon our press to devote as little space as possible to Spain, *including air raid precautions in Spain*. And our Press, under official inspiration, is putting over the most fantastic "dope" about A.R.P. Thus the *Evening Standard* for May 31st, 1938, contained an account of a test of A.R.P. in which "the raids were made realistic and spectacular in order to encourage recruiting for A.R.P. work." Some old property was set on fire, ostensibly by an incendiary bomb. Men in gas-masks and overalls "rescued a casualty." And an explosive was let off with such violence as actually to break a window. On the same day 500 people were killed by explosive bombs (not gas or incendiaries) in Catalonia, and an unknown number in China. It must be emphasized that these mock air raids are rather less realistic than an Aldershot tattoo, and rather less like a real air raid than a "mock trial" is like the Last Judgement. They serve to keep peoples' minds on gas as the principal danger, and fire as the main alternative.

I think it probable therefore, that if, as I believe, high explosive bombs are the principal danger, the entire air raid precaution schemes so far adopted are rather worse than useless.

We shall later consider what ought to be done.

SOME EXTRAS

I shall not deal in any detail with the contents of two other official documents¹ dealing with the protection of merchant shipping and food against poison gas. The former contemplates attacks on ships with mustard liquid sprays or bombs. It is recommended that at the outbreak of war the crew should be provided with respirators and protective clothing, and also that bleaching powder and other decontaminating materials should be carried. Canvas covers should be placed over winches, boats, etc., which may have to be handled, and means provided for closing ventilators. Further, washing facilities (e.g. showers) should be provided for the crew. One could wish that this measure of common cleanliness and decency might be available even in peace-time. And means for steam decontamination of clothing are to be provided. Decontamination squads are to be organized on a scale which seems adequate, and instructions for them are given. Further instructions for decontamination of personnel, and for first aid and treatment, are given. Elaborate arrangements are made for the control of contaminated ships in ports. Each Port Authority

¹ A.R.P. Handbook No. 7, 1938, and "The Protection of Foodstuffs against Poison Gas," 1937.

will appoint an Anti-Gas Officer, who will deal with contaminated ships when they come in, and furnish certificates of freedom from gas to outward-bound ships.

These precautions seem to me, if anything, slightly overdone, except that nothing is said as to the treatment of lung injuries. However, it seems more likely that ships will be attacked with explosive or incendiary bombs rather than gas. At the time of writing British ships are being so attacked in Spanish ports. A most valuable document for the mercantile marine would be a statement drawn up by some of the surviving officers and crews of these ships, giving details of the types of bomb used, and their effects, and of the methods, if any, which were employed for dealing with the damage done by them. Unfortunately such a document will not be issued by the present Government, as it would reflect discredit on it. However, it should be one of the first duties of their successors in office to produce it for the information of British seamen during a future war. For the attacks on British shipping in the Mediterranean may be regarded as a dress rehearsal for similar attacks in British waters.

The pamphlet on protection of foodstuffs against gas is not so good. It is entirely concerned with mustard gas and liquid contamination. Yet in 1917 and 1918 a number of British soldiers were poisoned by food and water contaminated by arsenical smokes,¹ or the solids which produce them, but which had been fully converted into smoke when a smoke-shell burst. As dichlorethylsulphide reacts with water to form harmless substances, while arsenic compounds are permanently

¹ *Medical History of the War*, Vol. 2.

poisonous, it follows that poisoning by arsenic compounds is not a negligible danger. Yet this is nowhere mentioned.

It is pointed out that air-tight bottles or sealed tins give complete protection, other glass and metal containers are not so good. Barrels, if properly sealed, are proof against vapour, as are thick wooden or cardboard boxes if their joints are tight, though both absorb mustard liquid. Oilskin, waxed cartons, and transparent moisture-proof wrappers are very impermeable. But ordinary paper and thin cardboard are little use, and sacking none at all.

Hence methods of packing are to be improved, and foodstuffs are to be kept wrapped up till the last moment. No uncovered foods should be displayed on shelves or counters in shops. Apart from this, storehouses should be made as gas-proof as possible, though the standard of protection is not so high as for human beings. Food in transport should be taken in closed vehicles as far as possible. Food on open vehicles, and in the open (including stores of grain and fodder), should be covered with tarpaulins. Special notes on ventilation are given.

All this is good as far as it goes. But it seems to constitute rather an elaborate precaution against a somewhat remote contingency. And it must be remembered that the more adequately we are protected against gas, the more our enemies will tend to concentrate on high explosive bombs. This tendency will be further accentuated if an undue preoccupation with gas leads us to neglect the far greater danger from high explosives.

After a prolonged squabble the Home Secretary has now agreed to subsidize the Metropolitan Water Board and similar bodies in taking Air Raid Precautions. The precise nature of these precautions is still undisclosed. Possibly they will include a measure of protection for exposed water-mains against splinters and small bombs. But nothing can be done to protect them against large bombs, except at the most enormous cost. And the experience of Madrid has shown that the shock from a medium bomb will burst a street main. The mains in Madrid have been mended, at a certain cost of life. Before the aeroplanes were out of the sky the municipal workers were digging down towards the bursts, and some were killed by bombs and machine-guns while doing their duty. The measures taken in London would presumably include the installation of extra turncocks, so that a damaged section of pipe can be cut off as soon as possible. This is of great importance, not only to prevent flooding, but to prevent a loss of water which may be needed to deal with fires.

To close on a note of comedy, the Zoological Gardens are taking special precautions. Keepers will be armed to shoot lions or other dangerous animals should they escape after their cages are broken open by a bomb. And on the outbreak of war it is proposed that poisonous snakes and spiders such as the "black widow" should be executed. Some persons living near the Zoo (as I do myself) have been greatly reassured by these measures. I presume that they would be equally relieved were precautions against the spread of measles enforced during an outbreak of pneumonic plague.

CHAPTER VI

PROTECTION AGAINST HIGH EXPLOSIVE BOMBS

THE DIFFERENT TYPES of shelter may be classified as follows:

1. Refuge-rooms in ordinary houses.
2. Steel frame and other strong buildings.
3. Splinter-proof rooms.
4. Cellars and strong-rooms.
5. Trenches and shallow dug-outs.
6. Deeper dug-outs and special shelters.
7. Underground railways and other tunnels.
8. Tunnels made for shelter purposes.
9. Bomb-proof underground shelters other than tunnels.
10. Conical towers.

The list is perhaps not quite exhaustive. For example, behind many of the stone barricades in the Madrid streets there are breast-works of sandbags, so that if a bomb falls in the street behind a barricade, the sentry will not be hit by splinters if he crouches down. And after being raided once whilst on a road in Spain, during the rest of my time there, and for some weeks afterwards in England I could not drive along a road without automatically looking for cover by its side. Even a small ditch or a hollow a foot deep is very much

better than nothing when bombs are bursting in the open.

REFUGE-ROOMS

The methods of strengthening one's rooms so far laid down by the Government are described in Chapter IV. They may save a few lives in exceptional cases, but it must be pointed out once again that very few splinters go through even a thin wall. In practice people out-of-doors are killed by splinters and flying stones, whilst those indoors are generally crushed by the houses; though of course if a bomb actually falls in a house they may be torn to pieces by the blast or mangled by splinters. But if the house is actually hit, a splinter-proof room is smashed into rubble like any other room.

I do not say that a protected room is absolutely useless. It may reduce the risk of death to those in it by 5 or 10 per cent. But it is hopelessly inadequate. And the recommendations are dangerous because they will give many people a wholly false sense of security.

STEEL FRAME BUILDINGS

Buildings of ferro-concrete or other materials with steel frames have a great capacity for resisting bombs. A quarter-ton bomb with a delayed action fuse may fall through five or six floors of such a building before bursting. When it bursts, it wrecks the room in which it explodes. It also smashes the walls, and wrecks the rooms on each side and below it. The people in these are almost certainly killed. The blast penetrates

upwards through the holes made by the bomb, and very often all the rooms through which the bomb has fallen are destroyed. Hence a whole vertical section of a building is sometimes demolished. On the other hand the building as a whole does not come down, though still heavier bombs may have this effect. Every window is broken, and many floors and walls cracked. But most of the people escape alive.

Smaller bombs do not do anything like so much destruction. If a district consists mainly of small houses it is likely to be attacked with 50 lb. or 100 lb. bombs, and a solitary frame building may escape with relatively slight damage, though one such bomb will smash an ordinary house. It has been stated that a ferro-concrete building in Shanghai was little damaged by a one-ton Japanese bomb. Although I have seen a photograph of it, I venture to doubt the story. It is of course possible that the bomb exploded on contact, and thus merely broke off a corner of the building. I think it more likely that the weight of the bomb was overestimated. It is extremely difficult to believe that the thing which has just made the loudest noise you ever heard, and smashed your best friend into obscene and unrecognizable pulp, only weighed 100 lbs. The reason for the greater stability is that an ordinary wall falls down if it is only moderately out of the vertical. Whereas a steel frame can resist a pull as well as a push. Further a solid wall transmits shock, while a steel frame buckles without thereby ceasing to be solid.

In any case, a man or woman in a steel frame building stands perhaps half or one-third of the

chance of being killed of a person in a neighbouring brick house. I therefore recommend that on the outbreak of war such buildings in crowded residential areas should be commandeered for billeting families who normally live in brick houses, unless the frame buildings are needed for essential war work.

Such measures will only be carried through by democratic pressure of local groups. The Government's slogan will probably be "business as usual," and such moves would interfere with business. They will also recommend dispersal, which does not increase the safety of the individual. It merely ensures that the bombs will kill people in a fairly even manner.

Where steel frame buildings are not available, very solid stone houses offer a considerable degree of protection. They are of course splinter-proof, apart from their windows, doors, and roofs, and will stand up to a good deal of blast. On the other hand, if such a house is brought down its inhabitants are most efficiently squashed. Moreover their floors may be demolished by blast entering through the windows. It is worth pointing out, however, that in London a large proportion of what appear at first sight to be stone houses are really built of brick or rubble with a stone facing, and are far from bomb-proof.

Churches are seldom wholly demolished by a single bomb. But they are unsatisfactory shelters, as a bomb falling on the roof usually penetrates it and bursts on the floor, so that refugees are killed by splinters, as they would be in the street. On the other hand the crypts under certain churches would be as good bomb-proof shelters as other cellars.

SPLINTER-PROOF ROOMS

Many suggestions have been put forward for splinter-proof and partially blast-proof rooms. For example, Mr. Scott, F.R.I.B.A., in a pamphlet¹ published by the London Trades Council, recommends a room which he states is "capable of giving protection against splinters, and of resisting the blast pressures of all but the very largest bombs bursting a few feet away: such a room should have brick walls 13½ ins. thick, and a concrete ceiling over capable of resisting small incendiary bombs and also affording protection if the upper part of a building should be damaged or set on fire: the window to the room should be smaller than usual, and have a high sill level, thus being more readily fitted with gas-excluding shutters and giving protection from splinters to persons sitting in the room."

Once again I think such a room would be better than an ordinary room. But I simply do not believe that it would stand up to the blast of even a small bomb (say 100 lb.) bursting a few (say 10) feet away, or of a large bomb (say 1,000 lb.) bursting 50 feet away (see Chapter II). I think therefore that it would give a false sense of security, and be considerably less safe than trenches.

Much the same applies, I believe, to the steel rooms which I have seen installed in basements for exhibition purposes. They are doubtless splinter-proof and gas-proof. But they are probably not proof against the

¹ "Protection of civil population in case of air raids," 1938. 24, Thavies Inn, London E.C. 1.

blast of a heavy bomb bursting in their immediate neighbourhood. One which I saw was in the basement of a large building. A heavy bomb with a delayed action fuse would penetrate the building to the basement. The lateral blast would then, I believe, smash the steel room. This would, I think, occur if a quarter-ton bomb burst within 20 feet of it. I was also extremely doubtful whether, had the building collapsed, the shelter would have supported its weight. And of course a direct hit even from quite a small bomb, if it penetrated so far, would be completely fatal.

Once again, such protection is better than nothing. A man in a room of this type would probably have his chances of death in a raid reduced to one-half or one-third compared with one in an ordinary room. But where the casualties in a single air raid may run into thousands, and adequate shelter is available, this is insufficient.

CELLARS AND STRONG-ROOMS

A really strong cellar makes a good air-raid shelter. It should have a vaulted roof, preferably of stone, and should not be more than about six feet across, though it may be considerably longer. Provided there are a few feet of earth above its roof, such a cellar furnishes protection even if the house above it is completely demolished, either by lateral blast from a large bomb, a direct hit from a small bomb, or by fire. It does not, of course, stand up to a direct hit by any but the smallest bombs, provided they burst immediately above it. And it would, I think, be demolished by

the shock-wave from a bomb of 500 lbs. or over bursting even 20 feet away.

Nevertheless in practice such cellars have saved thousands of lives in Spain. Nearly 1,000 of the inhabitants of Guernica were in such cellars when their homes were destroyed, and it is said that all of them escaped. It must, of course, be remembered that Guernica was largely destroyed by incendiary bombs.

Existing cellars can often be strengthened by steel girders and other means so as to support the weight of falling buildings. This is being done on a very large scale in Paris, and could be done in some parts of certain British towns. Unfortunately suitable cellars are rather rare in London. Where there are any subterranean rooms in a house they generally form a basement, and this is often at ground level on one side.

For example I have examined the basements of University College, London. Many of them give on yards at their own level. Others cover an area of thousands of square feet, and a bomb penetrating the basement at any point and then exploding would probably kill everyone in it. A few of these basement rooms are strongly vaulted, and would probably hold if the building above them were wrecked by blast or shock. They also have two entrances, a point of great importance. But in my opinion the majority would be death-traps. The same is even more obviously true of the basements of large stores. Where these are built with steel frames, the whole building is unlikely to collapse. On the other hand a heavy bomb would penetrate to the basement. Hence the first floor would probably be safer than either the basement, or the

ground floor, where splinters would probably penetrate if a bomb burst in the street.

Many buildings in the City of London and other business areas contain strong-rooms and large safes. These are probably as bomb-proof as cellars. That is to say, though not proof against a direct hit, they are completely proof against splinters and nearly so against blast, whilst they would not be crushed if the building fell on top of them. On the other hand they are generally unventilated, and if the door is shut, it might be impossible to open it after a bomb had burst in the neighbourhood, so that the occupants would be suffocated. I should personally recommend that if such rooms are used for shelters, the door should be kept ajar with a piece of metal, so that after an explosion it would not be completely closed, and air could enter. It would also be much easier to open, even if those inside could not do so owing to wreckage without. The door could, of course, be shut rapidly if gas penetrated the building, or there were a serious fire. Or an oxygen cylinder could be kept in the strong-room, which would render survival possible for several days.

TRENCHES AND SHALLOW DUG-OUTS

Trenches have proved very valuable in Spain. Not only are they used for shelter in and near the fronts, but also in the outskirts of some small towns. I understand that there has been a great increase in trench building since I was last there in January 1938. Undoubtedly the inadequacy of the trenches on the fronts and immediately behind them was

a principal cause of the loyalist defeat in Aragon in March 1938. The Spanish trenches sometimes have head cover, but this is rather rare. They are practically never revetted; that is to say the earth stands up by itself without planks or hurdles such as are desirable and often necessary in softer soil. On the other hand the soil is so rocky in some sectors of the front that trenches cannot be dug at all. But they can generally be dug near the towns.

Soldiers are unanimous that bombs are ineffective against troops in good trenches, provided they keep their heads. This does not mean that none of them are killed, or that it is not theoretically possible to take a trench system after aerial bombardment. On the other hand, it is not possible, even with an air force of over 1,000 bombing 'planes, to drop a weight of bombs on a trench system anything like the weight of shells which can be dropped on it in the same time by massed batteries of quick-firing artillery. There is no possibility, such as arose in the great war, of killing or wounding most of the occupants of a large trench system. The morale of the troops is however decisive. The men of the 15th Brigade, which included the British Battalion, stated that in a particular aerial bombardment they had had two men killed, whilst a neighbouring brigade where the men lost their heads and started running across the open lost several hundreds.

Similarly trenches are not a complete shelter for civilians. But they reduce the casualties immensely. It was a matter of remark that three people were killed by a single bomb in a trench system near a small Catalan town in May. Whereas thirty people

are often killed when a bomb wrecks a large building, and sometimes over a hundred have been killed by one bomb.

The lessons of the Spanish war cannot be applied without modification in Britain, for the following reasons among others. The soil is generally much less tough than that of Eastern Spain. This means that trenches are easier to dig, but also collapse more easily. It is also generally wetter, which means that the trenches are much more likely to be waterlogged. And we may hope that in the event of a war the British anti-aircraft artillery will be in action. This means that there will be a lot more metal falling vertically, and the necessity for head cover will be much greater. Further, there are many more towns in Britain than in Spain with over 100,000 inhabitants. And it is in such towns that the difficulty of digging trenches is greatest.

According to A.R.P. Handbook 6, trenches should be 7 feet deep, and 2 feet wide when used as passage ways, but wider when used as shelters. I have heard a high official of the A.R.P. department give 9 feet as a suitable depth. This seems to me altogether excessive. Personally I think 6 feet is ample. A good many trenches will be blown in by shock from bombs bursting in the neighbourhood. If they are not more than 6 feet deep their occupants may hope not to be crushed or suffocated under large amounts of earth. Again the deeper the trench the greater the probability that it will be flooded in water-logged soil.

We are told that the trench should be revetted. "One method is to use wooden frames with boarding, corrugated iron, or other suitable material behind."

This is probably necessary in the majority, but not all, of British soils. It certainly adds very considerably to the expense of trenches, and means that a large amount of material, other than picks, shovels, and the planks and corrugated iron to support the roof, will be needed. Alternatively the walls may be built up with sandbags, but this involves a good deal more preliminary excavation.

We are recommended to make recesses in these trenches, with seats in them, so that we sit with our backs to the wall of the trench. This may be correct. On the other hand the shock-wave from a bomb is much more violent than that from a shell of the same weight, and might give people sitting with their backs to the trench wall an extremely violent blow in the back. I should personally prefer to sit in a chair in the middle of the trench.

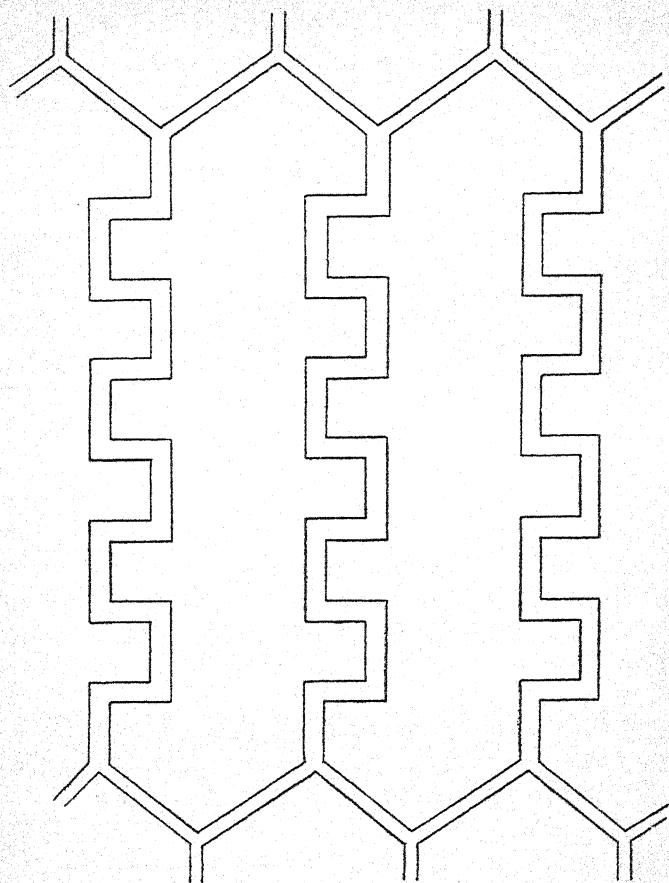
With characteristic incompetence the authors of Handbook 6 have said nothing about drainage, which is not forgotten in *The Defence of Your Home*. No old soldier is likely to forget the wet of the trenches in Flanders. If the soil is wet, or an appreciable section of the trench uncovered, a sump is needed into which water can drain, and from which it can be bailed out with a bucket or pumped out.

The general lay-out of trenches is a matter of controversy. Personally, for a large system, I should be inclined to favour something like Fig 1. But here I am sure that military experts could help us. The Spaniards have a, to me, inexplicable liking for zig-zag trenches, whereas I (perhaps as the result of a war fixation) favour numerous traverses.

Where should these trenches be in cities? Obviously parks, squares and public gardens are suitable. Digging them up involves a minimum disturbance of private life and business. And they are not traversed by water pipes, drains, or electric cables. These are a thorough nuisance in the underground trench systems of Madrid. I must have knocked my head three or four times on one particular pipe near the University City. Besides which one often breaks them when digging trenches.

In some parts of large cities there is a considerable area of yards and back gardens far enough from houses to be fairly safe. I should say that when a house is knocked over the main part of the walls falls within half of its height. Thus a garden trench 25 feet away from a house 40 feet high would be fairly safe if the house were blown down. (I confess that I would sooner be 40 feet away if possible.) On the other hand, yards among high buildings are no use for this purpose. But back yards are particularly accessible in many very poor residential areas where the houses are overcrowded and badly built, so that they would be easily destroyed by fairly light bombs of 100 or 200 lbs. and their destruction would cause a great many casualties. Cuatro Caminos, a northern suburb of Madrid, which was very extensively bombed by Germans in the winter of 1936-1937, was an area of this type.

It would be quite possible to build trenches in the London Parks and public gardens which would hold the whole population. And if there were an open space within 100 yards of every house, as is for example the



0 10 20 30 FEET

Fig. 1. Part of a trench system. The narrow parts at each side are 2 feet wide, and slope down from entrances at ground level to a depth of about 7 feet. They are open. The wider trenches are 3 feet wide and 7 feet deep, and roofed over. There is a semi-gas-proof curtain at each end, and if too great congestion is not expected, a seat along one side.

case in Buenos Aires, this would be a valuable scheme. But especially in the most crowded areas of the East End, a glance at the map shows that this is not the case. And things are still worse in many of the big industrial towns.

Finally, there are considerable areas, particularly in East London near the river, but probably also in Hull and other low-lying towns which are particularly vulnerable, where the water level in the soil is too high to allow of trenches being dug, unless they were lined with cement and provided with pumps to keep them dry.

Besides trenches, a number of people are building shallow dug-outs, with 6 feet or less of earth over their roofs. These are easier than trenches to gas-proof. They can also be made more homelike. But they are not so safe. To begin with, we may take it that anyone in a straight section of trench where a bomb bursts, or in a dug-out where it bursts, will certainly be killed. Compare a trench with a section 15 feet long by 3 feet wide, and a dug-out 12 feet square. The fatal area in the latter is three times as great. Further, unless the dug-out has a very thick roof, it is likely to be broken in by a moderate shock. For a beam spanning 12 feet will break under about a quarter of the strain needed to break a beam of the same size and material spanning only 3 feet. If on the other hand the roof is very thick, this means that if it falls in, the people below will be crushed. In fact it is probable that, unless your dug-out has a steel, ferro-concrete, or stout vaulted stone roof, anything less than 15 feet of earth above it is actually less safe than one or two. This is

hard to believe, and in practice during air-raids people do make for the deepest holes that they can find, regardless of safety.

The question of the part which trenches might legitimately play in British passive defence will be taken up later.

DEEPER DUG-OUTS AND SPECIAL SHELTERS

In 1937 a great many dug-outs were excavated throughout loyal Spain. In many villages the people burrowed into the hill-sides like rabbits. It must be remembered that in Spain many thousands of people normally live in caves or burrows. And the desire of some of them to come out into the sunlight is put down by ex-general Franco's supporters as due to Moscow propaganda. However that may be, they took to the ground very readily. Some of the dug-outs were probably completely bomb-proof. Others were proof against small bombs, but not against bombs weighing 100 lbs. or over.

However, they were a good deal safer than houses. And as the small villages were usually bombed with fairly light bombs, they may have stood up to these. I certainly did not hear of any cases where a whole group was buried alive in one. But I should be surprised if no such case had occurred. The vast majority of people, including myself, after being in one or two air-raids, have an overwhelming and irrational desire to get underground during one. And this is so even if the shelter is quite inadequate. A few people are immune to this.

For the rest of us, the tendency can only be combatted either by discipline, such as occurs in a good military unit, or by mass heroism, such as occurs in Madrid. It has to be fought, because it leads one to run out-of-doors for the nearest deep hole, instead of staying in a house or lying down in the open, which is safer if one has only a short time.

The technical journals are full of designs for semi-bomb-proof shelters. For example I have seen plans of one about 15 feet square, with 4 feet of concrete forming the roof, and two passages leading into it. There was an elaborate ventilating plant. It must be emphasized that such a shelter is definitely not bomb-proof, in the sense of standing up to a direct hit by bombs weighing over 100 lbs. It is a little safer than a trench, but probably more expensive than the completely bomb-proof shelters which will be described later.

I can see no serious argument for making shelters of this type, except the heavy profits accruing to certain firms, and the sense of security which they may give to ill-informed people.

A better case can probably be made out for cast-iron huts, such as the Nissen huts which were largely used as shelters by the British troops during the later stages of the Great War. These are about 8 feet high, with a semi-circular section. They can be covered with sandbags or earth, and also made gas-proof. For ventilation purposes a tube, supported by wire stays, draws air from a height of 60 feet or so, where gas concentrations are likely to be low. Or a filter may be added to the pump.

Such a hut is quite splinter-proof. It is proof against a blast which would knock a house over. On the

other hand it would not stand up to the blast very close to a heavy bomb. And it is not of course proof against a direct hit. As compared with a trench system it offers greater protection from gas, and far greater comfort, but not very much greater safety.

A word may be said about the so-called bomb-proof shelters which are features of some new London buildings, particularly blocks of flats. A good deal of play has very properly been made with these in the *Daily Worker*. It is pointed out that the rich can afford these shelters, while the poor must stay in flimsy brick houses. This is so. On the other hand it is quite a fallacy to suppose that these shelters are proof against any but quite light bombs. I recently visited a block of flats of which the cheapest, if I remember, had a yearly rental of £300. The shelter in the basement had elaborate air-locks and filters. On the other hand its concrete roof cannot have been more than 4 feet or so thick. And the "sandwich" principle (see p. 173) was not used in its construction. It was at least 50 feet long, and the span from the wall to a not very stout pillar in the middle was 15 feet. Finally it was incorrectly sited. It was under one side of a steel-frame building with concrete floors. Had it been under the middle it would have been much safer. Bombs do not fall vertically, and a bomb could have struck the roof of this shelter without having to penetrate even one of the floors above.

So I did not take even the £300 a year flat. For such a sum I should expect to get complete protection, protection of the kind which in this book I am demanding for all the people of London.

UNDERGROUND RAILWAYS AND OTHER EXISTING TUNNELS

In a great many cities there are tunnels of various kinds, of which the most important are generally underground railway tunnels and road tunnels, such as those under the Thames and Mersey. The railway tunnels include those of underground railways and of ordinary railways, such as those which take the L.M.S. and L.N.E.R. lines under the North London heights. Besides this a few cities, such as Newcastle-on-Tyne, have large numbers of underground mine galleries.

The underground railways may be divided into the shallow, generally going under streets at a depth of not more than 20 to 30 feet in brick or stone arched tunnels, such as the London Metropolitan and District Railways; and the deep, which are generally in metal tubes at a depth often exceeding 60 feet. Of course the distinction is not sharp. Thus most of the London Tubes come to the surface at the outskirts of London. The Madrid Metro is generally shallow, but deep in places. The railways traversing Barcelona are seldom in deep tunnels.

The shallow type of railway tunnel is very definitely not bomb-proof, though it is probably proof against medium bombs falling directly above it in some cases. And where this is not so, the shock would probably only bring the roof down locally. So that a person in a Metropolitan railway tunnel would certainly be safer than one in a house, and possibly safer than one in a trench. On the other hand the

stations are rarely safe. They are often covered by a roof only. And where they have earth cover this is usually inadequate, for reasons to be pointed out later.

The deeper tubes are bomb-proof, probably even against bombs weighing over a ton. But their stations are often not so. To begin with, some of them, such as Piccadilly Circus Station, have large areas quite a short distance below ground. Now if the roof of Piccadilly Circus Station were supported by stout ferro-concrete pillars a foot in diameter and ten feet apart, and further if there were a layer of cement three feet thick just below the road surface above it, it might, and probably would, be proof against all but the largest bombs, though still liable to flooding. But actually if a bomb burst in the Circus above it, the whole of its downward force would penetrate to the roof, and force it down. If you are in any doubt as to the principle involved, get a stick and lay it on two chairs three inches apart. A great force is needed to break it. Now move the chairs three feet apart. A small force downwards half-way between them will break the stick.

The station platforms are safe in some cases, but not in others. Sometimes there is a vertical shaft down which a bomb might fall. In other stations this is impossible; but one cannot distinguish the two types by simple inspection. Of course no part of the tube system is gas-proof.

The arguments for making the tubes available as shelters are obvious. Those against are as follows:

1. They will be needed for transport of men and materials, particularly if streets are blocked by wreckage, gas, or fire.

2. They are liable to flooding. A number of water mains and sewers traverse the stations. There is even a river confined in a pipe which flows through one District Railway Station (Sloane Square). A burst water main or sewer might flood large sections of the system, and drown tens of thousands of people.

3. If these railways were used there would be such congestion that many people would be crushed to death. This is particularly so where there are no escalators, but only a staircase and lifts.

4. Many parts of London are a mile or more from the nearest tube station. If it was known that the Tubes were open, people would rush to them from great distances, and would be caught in the streets when the bombs fell.

I have heard all these from Government spokesmen, though not all at once, for it is clear that (2) cancels (1) to a large extent. I think there is a strong conscious or sub-conscious objection to the gathering of large crowds anywhere. They are messy. They are a good target. And they are liable to emotions of which panic is not the only one. Rage is another. Arguments (3) and (4) are valid up to a point. The tubes are hopelessly inadequate as the only underground shelters for London. They might be very valuable as part of a comprehensive scheme. In the same way the Mersey tunnel might accommodate citizens of Liverpool and Birkenhead living within a quarter of a mile or so from its entrances.

The flooding danger is, I think, a real one. If so, it is up to our authorities to spend money necessary to divert water mains and sewers so far away from our

tube stations that no more danger exists. This would put at the disposal of the people of London a series of shelters which would accommodate hundreds of thousands of people. But it would only be a beginning.

The actual utility of the tubes may be gauged as follows. In my own borough of St. Pancras there are 11 tube stations. Of these only 5 are so deep that the station roofs are 60 feet or more below street level. In these stations, provided a train were standing at each platform, 10,000 people could be accommodated with no worse congestion than already occurs there. If the current were switched off, and people allowed to walk along the tunnels, they would take many more. But they could hardly be got into the entrances in the small time elapsing after a warning. As many people again could be accommodated in other stations which, though not fully bomb-proof, are more so than any cellar.

The total population of St. Pancras is 183,000. Of these 47,000 are children under 14, mothers of children under 5, and aged and infirm people. If they were evacuated, 136,000 would be left, of whom 10,000 could get first-rate shelter, and as many more second-rate shelter, in the tubes. It is thus clear that the tubes are very far indeed from negligible, though St. Pancras is unusually well off in this respect.

I have no information as to the abandoned mine galleries under Newcastle. But a few months' work by miners at present unemployed should suffice to render them safe, and a few coats of whitewash to render them tolerably clean. Some of them may be too near the surface for safety. There are probably not enough to hold everyone even in the districts

where they occur. But they would form a beginning, and an important beginning, to the protection of one of the most vulnerable of our great cities.

TUNNELS SPECIALLY MADE FOR SHELTER PURPOSES

These tunnels are the principal form of air-raid refuge in Barcelona. Mr. Skinner, an engineer who returned from that city in May, informs me that at that time there was shelter for about 240,000 people in brick-lined tunnels, whilst all other shelters combined held a much smaller number (I do not of course include trenches, cellars, underground railways, or any of the types of shelter which are considered good enough for Londoners by our Government). This is below the official figure, and the truth may lie somewhere between.

A typical shelter of this type which I visited in December 1937 had the following structure. In one of the hilly parts of Barcelona is a block of an acre or so which had been cleared for building purposes shortly before war broke out, though there were plenty of big blocks of workmen's flats around it. In this area there were four entrances which led down by ramps with a few steps, to the tunnels. The ramps twisted repeatedly, until a level of about 55 feet below ground was reached. Here began a labyrinth of passages about 7 feet high by 4 feet broad. They were cut in the very tough soil of the district, and had no lining, and I think no supports such as pit-props.

They were, however, being lined with tiles with a cement backing so as to give a semicircular arch, and

vertical walls. Lighting was to be electric, but none was yet installed. Ventilation was to be by electrically-driven pumps, and a vertical shaft which had been used during the excavation was to continue as a ventilating shaft. I commented on the possibility that a bomb might fall down this shaft. My guide regarded it as an unlikely contingency. I have since heard from an official British source hostile to a policy of shelters that a bomb has fallen down a ventilating shaft of this type, and killed a number of people.

We shall see later that vertical shafts are not needed. This shelter had been dug very largely by the local inhabitants on their own initiative, and with only a little guidance from the authorities. On the day when I visited it no one was working, as they were attending a mass meeting. It has been stated that the low cost of shelters in Barcelona was due to the fact that they were built by forced labour. This statement is typical of those by which our Government attempts at the same time to justify the monstrous wrong which they are doing to the Spanish people and to deceive their dupes at home. There is forced labour in Spain. I have seen quite cheery-looking gangs of prisoners working on the country roads. But there is no need to force the workers of Barcelona to protect themselves. The cost of these shelters is extremely low—about 150 pesetas per head, which is nominally equivalent to £1, and has a purchasing power of about £3. This is due partly to the very favourable soil, partly to the fact that production of all kinds is carried out by and through the Trade Unions, and the workers

are quite willing to work overtime because they know they are not working to make profits for others.

The cost of such tunnels in Britain will vary with the soil. Where this is tough and dry, and they can be driven directly into a hillside, it will be very small. Where the soil is waterlogged or consists of hard rock, it may be impossibly high. Fortunately figures exist which apply to most of Greater London. They are to be found in a most valuable paper¹ by Mr. D. M. Watson, entitled "West Middlesex Main Drainage." This describes a great system of sewers, emptying into the Thames at Mogden, near Twickenham, and serving an area including Ruislip, Mill Hill, Golder's Green, Wembley, Chiswick, Hounslow, Teddington, Staines, Uxbridge, and the included districts. These sewers, including over 47 miles of actual tunnels, were made at considerable speed between 1931 and 1936 at a cost of £5,250,000. They are built of brick, concrete, or cast-iron lined with brick and concrete. They are laid at depths below the surface which never exceed 60 feet. The total length of sewers of six feet or more in diameter is $22\frac{1}{2}$ miles. These sewers are tunnels which, if they were dry, could be used as shelters, though some would be dangerously near the surface.

The sewers mainly run through London clay, and were partly made by open trenches, but mainly by tunnelling, as this is cheaper for deep sewers, and does not involve tearing up roads, water pipes, and the like. The cost per yard of a brick-lined sewer 7 feet in diameter is £25, this being the average of the three

¹ Journal of the Institution of Civil Engineers, 1937, Vol. 5, pp. 463-566.

lowest tenders. These sewers are lined with special bricks, and made absolutely water-tight. The cost would be very considerably less were this not the case. Now in a 7 foot tunnel with benches at the sides, 3 large men could sit per yard of length. Actually 4 average people per yard could be accommodated comfortably. This means that the cost per person sheltered would be £6 5s. And there would be room for others standing.

However, this figure is a good deal too low. In the first place it does not include the sloping approaches leading down to the shelters at 60 feet or more below ground level. These would probably add 30 per cent. to the cost,¹ bringing it up to £8 15s. od. per head. The cost of ventilation would depend on whether or not the air was to be filtered so as to make the system absolutely gas-proof. This would cost £2 per head for filters and pumps.

The details are as follows. The Carrier Engineering Co. make filters of which the paper section, designed to stop smoke, conforms to French official standards, which are severer than British. The standard of ventilation is that laid down by the Home Office of 150 cubic feet per person per hour. On this basis a small plant with filters, and pumps to be worked electrically or by hand, costs £147 for 15 people. For 100 people it costs £337 with a rebate which may reduce it to £300. Larger plants for up to 1,000 people cost as little as £2 per person, this being the minimum figure.

But at this rate of ventilation the air would only lose, on the average, $\frac{1}{2}$ per cent of oxygen, which is harmless. The ventilation could be halved without

¹ See p. 212.

danger in a really air-tight tunnel system. In a cellar, or even a concrete chamber, the walls always leak seriously, and a positive pressure must be kept up to exclude gas. In an underground tunnel a very small ventilation produces quite a large positive pressure. Indeed at the Place des Fêtes Metro Station in Paris, where the Carrier Company installed a plant, it was necessary to cut large holes in doors originally intended to be gas-proof, so as to let the air out. Actually the main function of doors would be to protect against blast rather than gas.

In a shelter designed to hold 1,000 people, with a rectangular entrance 7 feet high by 6 feet broad, the standard rate would give an outward current of 1 foot per second, which is quite an appreciable draught, and could certainly be cut. On the other hand, for these large units an alternative source of power to the electric current would be needed. This would perhaps bring the cost up to £2 again. I also allow another 10s. per head for ducts, and 10s. for lighting, seating, closets, and other extras, making a total of £11 15s. od. per head.

This is only a rough figure. I have no first-hand experience of most branches of civil engineering.¹

¹ Since the above was written I have been shown the summary of the report of a committee of the Association of Architects, Surveyors and Technical Assistants under the chairmanship of Mr. John Pinckheard, A.R.I.B.A. This report is to be published in a special number of the Architects' Journal, and I strongly recommend all readers of this book who are interested in technical details to read it. This committee arrives at a figure of £11 per head for a system of tunnels 50 feet below the surface of London, and lined with steel sheeting. This figure is based on detailed estimates which are of course beyond my power. It is nevertheless very gratifying that our estimates agree so closely. It is probable that steel sheeting would be superior to brick as a lining, because it is more elastic. I had of course considered this point, but I gave figures based on brick because I wished to base my estimate on actual experience of costs, rather than on estimates which might be questioned.

The prices might be lowered considerably by the use of cheaper bricks and by omitting the very skilled work necessary to make the interior of a sewer as smooth as possible, so as to oppose as little resistance as possible to the flow of water. On the other hand prices would be a good deal higher in water-logged soil, where it is necessary to work with compressed air and a shield, and the tunnels must be cast iron tubes like those of the underground railways on a small scale. Actually in West Middlesex compressed air was needed for less than 3 out of 47 miles of tunnelling. In this case the cost per yard of a 7 foot tunnel rises to £41 if it is lined with brick and cement. This would bring the total cost per head up to about £16. On the other hand the London soil improves as one goes down, the clay, which is usually met with at a depth of much less than 60 feet, being very well adapted for tunnelling. The criticism will doubtless be made that deep tunnels will cost more than ordinary sewers. I therefore quote Mr. Watson (p. 495). “. . . the cost of tunnelling is very little affected by the depth below surface . . .”

The rate of excavation for a brick tunnel $6\frac{1}{2}$ feet in diameter averaged 12 feet per day, for a cast-iron tunnel excavated with a shield and compressed air, 18 ft. 4 ins. per day. If labour-saving devices, such as electric shovels, were used, the progress would be much faster. E.g. in Chicago, 20 feet per day is a usual rate for sewer construction in clay without the use of a shield. These rates could at least be doubled if three shifts were employed, so that men were working night and day.

I shall take up the details of a tunnel system for London in Chapter VIII. Meanwhile it appears

that the cost of making 1,100 miles of completely bomb-proof shelters 60 feet or more underground for eight million people would be about £100,000,000, and probably rather less. Naturally, as many Londoners work in one place, and sleep in another, this would not give day and night protection for all. The provision on similar lines of shelter for a total of thirty million people would cost something like £400,000,000. This is a large sum, but it is about one-quarter of what we are to spend on re-armament during the next few years.

Some idea of the actual efficiency of a system of tunnels can be obtained from William Forrest's despatch from Castellon to the *News Chronicle*, published on May 30th, 1938, which I quote almost in full.

"Fifty rebel warplanes raided Castellon recently. They dropped four hundred and fifty bombs. There were seventy thousand people in the city. And only one was killed. A week later the raiders returned in force—nineteen Junkers escorted by nine pursuit 'planes. This time they dropped one hundred and eighty bombs and destroyed sixty houses as well as the civilian hospital. Two women and three children were killed in the hospital, but in the city itself the death-roll was nil. Castellon, it is clear, has solved its A.R.P. problem.

"What could the explanation be? I found it in a great heap of clay. Workmen were coming out from a house carrying basket loads of clay and depositing them on the heap. I asked them what it all meant, and they invited me to come inside the house and see. On the floor of the vestibule was a trap-door lying open. Twelve steps or thereabouts led down to a

landing. Twelve more to another landing, and there was yet a third flight of 12 to descend before I touched bottom. Here at a depth of 40 feet below ground two men with picks were preparing a vault big enough to accommodate all the families living in the building overhead. In the streets of Castellon you will see not one heap of clay but scores. 'A refugio in every house'—that was the watchword issued to the people of Castellon when Franco's forces, having reached the Mediterranean, began to push down the coast. And the people of Castellon, knowing that the bombers would soon be overhead, preparing a way for the enemy advance, acted on the watchword at once, and with a will.

Men, women, even children, toiled with pick and shovel and a basket, digging every day deeper and deeper, until they reached the recommended bomb-proof depth of 40 feet. Then they drove tunnels from one dug-out to another. Now, with this subterranean network of vaults and corridors nearing completion, the whole of Castellon's population can be housed underground. There are now, in fact, two cities—Castellon on top and Castellon of the catacombs.

"At night the people sleep on the ground floors of their houses, and when the air raid siren sounds they just open trapdoors and troop below. If a house is wrecked by a bomb they pass along a corridor to the next dug-out, and thence emerge to safety. The other night there were no fewer than seven alarms. This does not make for sound sleep, but it makes for safety first. The same thing happens during daylight raids. Everyone who is indoors goes down below, and for those who are caught out of doors there are

refuges in the streets. They have them, too, in all the shops. 'You must see our refugio,' the proprietor of a coffee bar said to me with pride. All the people indeed, and particularly the housewives, are proud of their refugios. They have every right to be. Thanks to their foresight they can face the totalitarian terror of the air with equanimity. Every bomb costs a minimum of £7. In one night the Dictators sink hundreds of pounds in Castellon—and Castellon comes up smiling in the morning."

These dug-outs are only 40 feet below ground level, and unlined. I am recommending brick-lined passages at a minimum of 60 feet. Castellon is (or was) a city with few very large buildings. It was therefore presumably attacked mainly with medium bombs not exceeding 2 cwts. or so in weight. I have little doubt that if a half-ton bomb had burst directly over one of these shelters the roof would have come down, and the inhabitants would at best have been injured, and at worst buried alive.

While the above quotation shows the value of deep underground shelters, it must not be taken as an example to be followed in detail. To begin with, few British cities have so favourable a subsoil as Castellon, though in some parts of London a very firm clay is found a few feet down. Secondly, people will only work day and night under a very strong stimulus. The only thing which could induce the people of Britain to take this sort of action would be either a series of air raids, or a declaration from the Government that the precautions so far suggested were almost wholly futile, and that the only safety lay deep underground. Finally as things are at present it is probably

illegal, and certainly unsafe, to start digging under houses. And it is certainly illegal to dump large quantities of earth in the street.

The energy liberated by a bomb is roughly proportional to its weight. And the area of the shock wave increases as the square of the distance from the burst. So at 70 feet the effect would be just one-third of that at 40 feet if none of the energy were wasted in heating the soil. But a great deal is so wasted. And the brick, cement, or cast-iron lining vastly increases the efficiency of a shelter. I therefore think well-lined tunnels at 60 feet would be safe even against one-ton bombs.

OTHER TYPES OF BOMB-PROOF SHELTER

There is an immense amount of technical literature on this subject. And on the principle that most theologies are untrue, we can conclude that most of it is worthless, because the different statements disagree with one another.

For example, in an Italian book on the subject a certain constant is given ten times the value which it receives in a corresponding German book. This involves a thickness of concrete $\sqrt[3]{10}$, or 2.1 times thicker. Of course some really satisfactory experiments may have been made. But their results are not available to the ordinary architect. Perhaps they will be published in A. R. P. Handbook No. 5. A semi-official British document states that complete protection from a 500 lb. bomb of the ordinary type with a delayed action fuse can be obtained by means of 3 feet of concrete at ground level to burst the bomb, 4 feet of sand, and then 4 feet of concrete. This seems to me reasonable

provided the span of the underground chamber is not too great. And it might not resist an armour-piercing bomb of the same weight. The soft intermediate layer is essential.

“Merciful Heaven,
Thou rather with thy sharp and sulphurous bolt
Splits the unwedgeable and gnarled oak
Than the soft myrtle.”

On the one hand a bursting layer of hard material must be used to break the bomb's fall. Otherwise it may bury itself to a considerable depth in the ground before it bursts. Then the shock must be prevented from travelling in a sharply defined wave by gaps of various kinds, filled with earth or air.

One shelter in Barcelona consists of two concrete shells separated by an air gap, a type which has been recommended by theoretical writers. I have little doubt that a sufficient number of such shells would be effective. The usual type of concrete shelter in Spain, however, has no air gaps. We may begin by describing the standard type in Valencia, of which one is to be found every few hundred yards along the main streets.

The shelter is a rectangular structure about 27 yards¹ long by 11 broad. It stands up about ten feet above the street level, and is illustrated in Fig. 2. About 15 feet below street level there is a chamber with a floor of earth and a vaulted roof reinforced about 7 feet above it. This is divided up into chambers or cells separated by stout concrete walls. A passage runs down the middle. There are seats round the walls and a

¹ The measurements which follow are my own estimates. It will be appreciated that a foreigner cannot openly measure refuges without exciting suspicion.

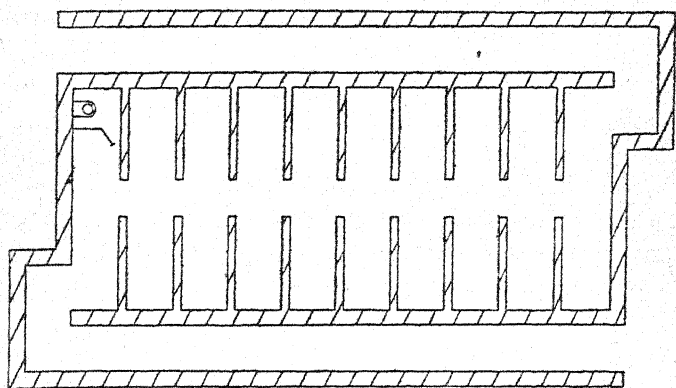
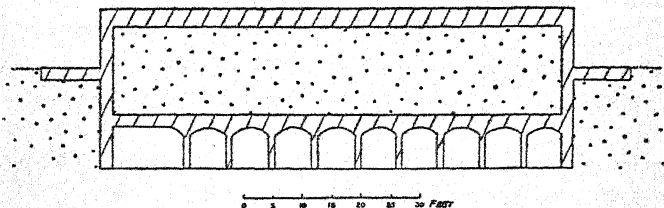


Fig. 2. Plan of a cellular reinforced concrete shelter. The entrance passages are sloping ramps. There are seats round the walls of each cell.



Section of a cellular shelter. Cement and concrete shaded. Earth dotted.

lavatory in one corner. Above the concrete roof, which is several feet thick are some 15 feet of earth, and above that 3 feet of cement. The earth is held in place by thinner walls of cement. At two opposite corners a door which is kept locked except during raids opens into a passage which runs along the long side of the shelter at a slope of 1 in 5, leading to an entrance to the basement at the far end. These shelters are often brightly painted, gay-looking little buildings, and may have frescoes inside and flowers on top. Sometimes, if I remember, the roof is supported by stout pillars instead of walls. Each shelter is designed to hold 500 people, but will take about 750 at a pinch.

In Barcelona some of the concrete shelters are considerably larger. One, which was to occupy the site of a former garden of about 2,200 square yards, was being made in December 1937, and was intended to hold 4,000 people. The earth was excavated to a depth of 20 feet or so. The surface was then shaped into domes. Between each four domes was a hole about 6 feet deep and one foot in diameter. Metal rods were then put in place and concrete poured on. The earth was then replaced on top of the concrete, and at the same time the earth beneath it was dug out, leaving a series of vaults supported by stout concrete pillars a foot in diameter by 6 feet high. When all the earth was replaced there would thus be about 21 feet of it above the concrete roof. The usual 3 feet of cement were to be placed above the earth. Four distinct entrances were being made to lead down from the street. There was to be a simple ventilating plant. The cost per head was said to be about 450 pesetas

177

(say £3 at the then official exchange rate, and £10 in purchasing power).

Another refuge to hold about 2,000 people was being made near the sea, where the water level in the ground was high. Its floor was only a few feet below ground level. And sand was to be brought from elsewhere and piled on top of it. In this case natural ventilation was relied on.

These structures have only rarely been hit, but so far they have stood up to bombing quite satisfactorily. One in Valencia was struck by what was said to be a quarter-ton bomb. I cannot of course vouch for the weight myself. This can generally be determined by comparing the fragments with unexploded bombs of known weight. The bomb in question cracked the concrete considerably, though not, I think, that of the actual vaults, and killed some people in the street. However, no one in the shelter was hit, though they may have been alarmed by the noise.

In Barcelona a bomb fell immediately above a shelter of a less effective type, which I have not described. This was a tunnel about 6 feet across and 7 feet high, with an arched concrete roof 2 feet thick, and not reinforced. Above this was 8 feet of earth, and on top of the earth a layer of 6 inches of concrete and 8 inches of stones. A 2 cwt. bomb fell above the shelter. Its burst made a crater about a yard in depth. The roof of the shelter was cracked, but did not fall in.

I was told that the larger types of shelter which I have described were considered to be safe against quarter-ton bombs. A half-ton or heavier bomb might possibly knock the roof in immediately below its point

of impact, killing ten or twenty people out of many hundreds. But even this was not certain. And it must be remembered that a single bomb of this size can readily destroy a dozen large houses.

The cost of shelters of this sort in Britain has been very variously estimated. Without filters, gas-proof doors, and so on, they could hardly be made at less than £20 per head. These might add considerably to the cost. I have seen a number of estimates varying from this sum up to about £50, and have no very great confidence in any of them. Some of them were obviously drawn up by people who wished either to make profits out of them or to prove their impracticability. For example elaborate gas-proof doors were provided, as well as a powerful and efficient pumping plant which would ensure a positive pressure inside the shelter, and thus make such doors unnecessary.

Many advocates of shelters have plans for "killing two birds with one stone" when making them. Thus Sir Malcolm Campbell, who deserves great credit for his persistent advocacy of bomb-proof shelters since 1934, suggests¹ that they should be built under squares, and serve as garages or parking places in peace time. Now even if part of the space were divided up into vaulted compartments holding one car each, with stout walls between them, a large space would have to be left in which cars could turn. But as was pointed out earlier, a big roof span will not stand up to downward forces which a smaller span can quite well resist. As the garage would have to have a cement floor, cellular refuges might of course be built under-

¹ *A. R. P. News*, Vol. I, No. 1.

neath this, the main garage acting as an air gap to keep the shock off them. I am by no means sure, however, if this would be a very practical or economically sound proposition. I have no doubt that the above criticism has been used in official circles for shelving Sir Malcolm's scheme. Our rulers are considerably more expert in destructive criticism than in constructive planning. And at least people would be somewhat safer in a subterranean garage than in an ordinary house, or of course in a street.

In Barcelona some of the shelters were intended to be of public value in peace time. In one case the earth was to be removed, concrete plugs taken out from the crowns of the vaults, and replaced by skylights. The vaults were then to become a public bath-house. Another shelter was to serve as the foundation of a school, the refuges being used as gymnasia and store rooms. Frankly, I doubt if either refuge is very well adapted for the purpose in question, and I think these proposals bear witness to the enthusiasm for social work which prevails throughout loyal Spain, rather than to the possibility of beating swords into ploughshares, to use a biblical phrase.

According to Sir Samuel Hoare's speech¹ of June 1st, 1938, at least one really bomb-proof shelter will be made. "Are we taking effective precautions," he asked, "to ensure the working of the Government machine in an air war? . . . In that event the home General Headquarters must be as safe as any military G.H.Q. in a former war. The operations of civil control must work as quickly and decisively as any military

¹ Times, June 2nd, 1938.

command. . . . The Government are urgently engaged on this vital problem . . . I can say that we have advanced very far with our arrangements for an invulnerable battle headquarters."

I am sure that the news that Sir Samuel will be safe during a future war, whoever else is not, will be particularly welcome to the surviving Abyssinians, on whose behalf he had solemnly and repeatedly pledged his word to put into operation Article 16 of the League Covenant, and whom he actually deprived of the means of defence against Italian bombers by closing the British frontier to the export of arms.

Many, perhaps most, people will agree that our Government should be protected against air raids. The French ministries in Paris are reported to have been provided with bomb-proof and gas-proof basements. But this view is not universally held. When I met General Miaja in Madrid he was working in a deep and nearly if not quite bomb-proof cellar, as was right and proper. He had already given sufficient proofs of his courage. But in Barcelona, in December 1937, at a time when the city was being bombed several times weekly, Dr. Negrin and his cabinet held their meetings on the ground floor of an ordinary house—not even a steel frame building, if I remember correctly—near the centre of the city and some distance from any of the really bomb-proof shelters. Dr. Negrin was aware of the importance of civil control. He was also aware of the importance of an example of courage. And the Spanish people realize that if he is their ruler and leader, he is primarily their servant. Being a heroic people, they will only give their allegiance to a

heroic man. The British Government claims that its policy is realistic. But too complete a neglect of the moral factors in war, as of the moral factors in foreign policy, may not be the highest form of realism.

FERRO-CONCRETE TOWERS

It appears that in Germany conical towers are being erected, or will be erected, as shelters. They are to be about 80 feet high, and shaped roughly like lighthouses, with a conical top, a tapering body, and a slightly broader base. The walls are made of concrete 4-5 ft. thick. The inside will be occupied by a series of platforms, each with seats, connected by a spiral staircase. Each will hold about 600 people. Ventilation is from the top. There is no filter. The idea is that a bomb would glance off the side, and burst harmlessly. Now it must be remembered that bombs do not fall vertically, but at an angle which depends on the speed and height of the 'plane, and to a less extent on the weight and shape of the bomb. An angle of 30° to the vertical is not uncommon. It is therefore possible that a bomb might hit the sloping side at an angle of 45° or so, in which case it might burst on impact, if it were arranged to do so, and thus wreck the tower. It may be that the German Air Force has experimented on such a tower and found it invulnerable. If not, I confess that I should prefer to be under ground rather than well above it during an air raid. It is perfectly conceivable that these towers would be of great value. But in this book I propose to deal, so far as possible, with defensive measures which have actually stood the test of experience.

CHAPTER VII

EVACUATION

EVACUATION IS A comfortable word for a process which is at best uncomfortable, at worst appalling. In January 1937 I travelled down from Albacete to Alicante on a train containing refugees from Madrid. The train was six hours late. As I was a privileged person, and also suffering from the after-effects of influenza and from violent rheumatism, I was not only allowed to wait in a waiting-room, but even given a first-class ticket. However, if the classless society has not been fully realized elsewhere in Spain, it has certainly been achieved in the railway trains. I got into a coach, third-class as it happened, and forced my way into the corridor. The train was full—quite definitely full—of refugees from Madrid. They had travelled for some thirty-five miles in omnibuses to the railway station nearest to the capital, and had since been in the train for eighteen hours.

They were mostly women and children, with some old men and a sprinkling of wounded soldiers. They had brought such belongings as they could carry, pathetic bundles of clothes and "valuables" such as alarm clocks and photographs, wrapped in blankets or sacking; for they were too poor to own trunks or handbags. These occupied most of the floors of the compartments, and even some of the wooden seats. The children, and in one case a small puppy, were

perched on the top of these bundles. The adults were wedged between them. The rest of the compartments, and the corridors, were tightly jammed with standing people. Some of the children and the younger women were talking, and even singing. The babies were generally crying, the mothers almost paralysed with fatigue.

As there was no possibility of getting along the corridor in less than five minutes or so, the small children and the dogs relieved themselves on the floor. The weather was extremely cold, and every window was tightly shut, by which means the temperature was kept up. Any other smells were completely obliterated by that of some peculiarly formidable cigars called *puros*. These are used by *dinamiteros* for lighting their bombs, because they remain alight under almost any circumstances. It may be that their smoke possesses a germicidal power. To a man like myself, already suffering from laryngitis, they were more nearly homicidal.

Having a greater experience of war travel than anyone else in the train, I finally discovered an excellent and neglected part of the floor under some folding seats on which three people were sitting in the corridor. I lay down under these with a firm disregard of the varied and unmentionable forms of dirt which existed on the floor, and slept for about six hours, though people occasionally trod on me. For I was tired, as people can only be tired in wartime, when one learns that fatigue can master every emotion, love and hate, terror and bravery, curiosity and disgust.

At one station we were given bread, and drank water in the hygienic Spanish way, squirting it into our throats from a leather bottle, without touching it with our lips.

After twelve hours or so we got to Alicante. The refugees, who had left Madrid, 200 miles off, forty-eight hours before, staggered out. They did not know where they were bound, but they were met by guides on the platform. I wonder how many of my companions in this train have since been killed in air raids on Alicante.

This, of course, is an account of luxury evacuation.¹ Quite often a whole population sets out along the roads. From time to time an aeroplane kills a few with light bombs or machine-guns. The survivors scatter into the fields. But they must go on. So they soon come back to the road. The more optimistic have attempted to carry something, if only a change of underclothing. Soon everything except the babies is dropped. And if one is killed or seriously wounded the babies are dropped too. Boots wear through. Then the skin of the feet wears through. Of course if one is in luck one may find a pair of boots to fit one on a dead man or woman. It is not pleasant to walk on wounds, but it can be done, and is done. It would be easier if one had food to sustain one. If a family is separated during one of these migrations, it is very possibly separated for ever. Perhaps it is better not to write about these things. But evacuation is something quite different from a bank-holiday excursion.

It is very difficult to get people to evacuate Madrid,

¹ Definitely the funniest scene in an otherwise excellent film, "Blockade," is that in which Madeleine Carroll occupies the whole of a "Ladies Only" compartment in a Spanish train during the war. The train which I have described was the best train of the day. None of us were in goods trucks. The other defect in the film was that the babies were too fat. You could no more film a baby that had been starved as many Spanish babies are starved than you could film the crucifixion of a living man.

although a few shells fall on it on most days. When I was there in April 1937 there was a huge poster in the Puerta del Sol representing women and children fleeing from burning buildings, and bearing the words "Evacuad Madrid." It was still there in January 1938, and there were threatening notices on the walls, saying that towards the end of the month food supplies would be cut off from those who had refused to evacuate when ordered to do so. But people realize that nowhere in loyal Spain are they safe from bombing aeroplanes. Occasionally evacuation goes smoothly enough. In April 1938, lorries evacuated 30,000 people from Tortosa in one night, and when the bombers blotted it out (it had been a pleasant little town) during the following days, they only killed some animals, and those few partisans of Franco who were in the city and who had hidden themselves during the evacuation.

I have devoted these pages to a description of evacuation because the newspapers have devoted a good deal of space to descriptions of air raids, and much less to evacuations, which can be almost as unpleasant.

As we saw, the British official documents recommend an unorganized evacuation of our cities when war threatens, by those who can afford it, while leaving a blank space for organized schemes. However, according to Sir Samuel Hoare's speech of June 1st, 1938, he has actually begun to think about how to fill in these gaps. "That question," he said,¹ "raises so many issues that although we have plans prepared in outline, I should be very loth to decide upon any one of them until I felt that there was a general body of public

¹ *Times*, June 2nd, 1938.

opinion outside behind it." One would have supposed that after this he would have informed the public as to these plans, and asked it if it approved. But he did not do so. After all he has reason to be shy of "a general body of public opinion." He has already resigned office once as a result of the verdict of public opinion upon his activities.

Instead, he has "handed the baby" to a committee of four members of Parliament under the chairmanship of Sir John Anderson, representing the Scottish Universities, and formerly Governor of Bengal. We shall see what are the kinds of questions which they will have to decide.

Mr. Geoffrey Lloyd, M.P., the Under-Secretary for the Home Office, stated¹ that the evacuation of large numbers of people from London was not difficult if the actual technical decision that the evacuation was to take place at a given time was taken in time. In other words if Goering is kind enough not to attack us when we are most vulnerable, everything will be grand. "The Home Office had gone into the question with the railway companies, and had worked it out in detail. The time-tables had been worked out on a basis that 3,500,000 people could be moved 50 miles out of London or beyond by railway in 72 hours. . . . On the other hand they had considered what would be the position if the railway terminals and railways were damaged, and they would have to fall back on road transport. The Home Office had consulted the London Passenger Transport Board about the collection of refugees from London and their radial distribution at some distribution centres, and they knew something

¹ *Times*, June 2nd, 1938.

about the food problem in connexion with the evacuation problem and how to tackle it. . . . The principles of the schemes for reception of refugees and their dispersal over country areas had been worked out and could rapidly be taken further." And so on.

Of course this is a complete reversal of the policy embodied in all the official documents so far, in which the main emphasis was placed on "The Protection of Your Home" and not on "The Evacuation of Your Home." In other words, if there is any question of evacuating about half the population of London, the Government policy up till now has been entirely wrong, and the official propaganda which is still being poured out through officials and newspapers, is dangerous nonsense.

Every evacuation scheme has three parts. First persuading or compelling the refugees to leave, and getting them onto vehicles. Second, transporting them to their destination. And finally providing them with food, shelter, and sanitation. Mr. Lloyd's reply deals almost entirely with the second, which is far the easiest in Britain, though very difficult in Spain. You can form some idea of the situation there if you imagine the necessity of an exodus from the Yorkshire towns across the moors into Lancashire. Actually a situation never arises where all three parts of an evacuation are easy. People are only willing to leave their homes after so much bombing that transport is at least partially paralysed. And they are only willing to give full hospitality as honoured guests to their starving and lousy fellow-countrymen after they have learned patriotism (which means love of your fellow-country-

men even though they are lousy) in the stern school of revolution.

WHO WILL GO?

Rather than provide them with shelters, the Government is seriously proposing to evacuate three and a half million people from London, and perhaps another seven millions from other large and vulnerable towns. They hope to do this before war breaks out.

Let us picture the situation. There has been a spot of bother between Germany and Holland. A Dutch minister has made a threatening speech in which he states that his countrymen would be prepared to defend themselves if necessary. Herr Hitler demands an immediate apology, and on the advice of the British Government it is given. Mrs. Smith does not even trouble to read Lord Beaverbrook's powerful article in the *Daily Express* entitled "The Crisis is Over." She turns to the accounts of the latest weddings and murders. Her husband has gone to work, breakfast is cleared up, and the baby is asleep.

Suddenly there is a rap on the door. The policeman hands her a railway ticket to Princes Risborough, and tells her to be at Paddington Station at 4.25 p.m. with the baby and any luggage she can carry, including a blanket. She is to leave a message for her husband to write to Princes Risborough Evacuation Centre. He hasn't time to argue with her. There are many others to warn. Does Mrs. Smith turn up punctually at Paddington at 4.25 p.m. complete with baby and bag? I very much doubt it. She is a good wife, and her first thought is "Who is to cook Bill's dinner?" Besides,

she has just had a long talk with the local air warden, and has arranged for a gas-proof room in her house. She has no intention of risking her life and the baby's by going out without a respirator. Three days later she realizes that the world is at war. She has been issued with a respirator. Perhaps she even has a bag for the baby. This time she does go to Paddington Station. But as she gets there an enemy aeroplane releases sixty bombs five miles up. Only six of them go through the roof of Paddington Station, and they are quite light ones—only 50 lbs. But a splinter from one of them happens to cut off the baby's right hand and go on into Mrs. Smith's heart.

That is how evacuation would work out in practice, even if adequate schemes were prepared, provided the people were not also prepared. Every step is being taken to avoid panic. But a woman must be in a state bordering on panic if she is to leave her home and husband at a moment's notice for an unknown destination.

There is one class of the community which could be evacuated at very short notice, and with very little difficulty. These are the school children, and particularly the elementary school children. They are accustomed to obey their teachers, at least up to a point. Five hundred school children are easier to manage than fifty adults, unless of course the latter have been drilled.

Every school child in London and in every other town could be got out with the greatest ease in a single day. This would still be so even if every railway station were wrecked. There are 5,000 motor omnibuses in

London. Each will take 70 children with as much luggage as they can carry. There are about 500,000 elementary school children in London, and they could all be got away in two backwards and forwards journeys of 70 per cent of the buses.

However, there is a division of opinion as to whether families should be broken up, as appeared in the debate of June 1st in the House of Commons. My own view is that the correct policy is as follows. Parents should be told that children will have priority in evacuation, and asked whether they consent to their children being taken to the country the moment there is an alarm. If the situation were explained to them I think at least two thirds would consent. It would mean a separation of children and parents, but not necessarily for long, provided each area of a large town were evacuated into one particular country area—say North Battersea to be dispersed round Redhill and Reigate, and so on. In Spain of course many children have been permanently separated from their parents. Neither knows whether the other is alive or dead.

It is quite certain that all evacuation involving the breaking up of families must be voluntary. It might be justifiable to apply some persuasion, if not force, to move whole families out of specially dangerous areas, for example the neighbourhood of the London docks, and possibly Chatham and other towns on the Medway. Where men must stay to do essential work in a dangerous area, their wives and children would in some cases be urged to evacuate, whilst arrangements were made locally for feeding and otherwise

caring for the men. But such statements as these show the profound character of the social disorganization which would result from large-scale evacuation.

To sum up, I should recommend the following order of evacuation:

1. Children of school age from all large towns considered vulnerable (e.g. London and Hull certainly, Sheffield and Birmingham probably, Glasgow and Cardiff doubtfully). The case of small towns is considered later.

2. Mothers, babies, and old people from the most dangerous areas in these towns.

3. Mothers, babies, and old people from less dangerous areas.

I fully realize, however, that this is a matter for discussion. As however our rulers are asking for "a general body of public opinion" on evacuation, and refuse to produce definite plans, they cannot complain if members of the public put forward such plans as this.

HOW WILL THE REFUGEES GO?

Mr. Lloyd is very confident of the capacity of our transport to deal with the problem. The French authorities are far less so. They do not rely on the railways for the partial evacuation of Paris. They are building new arterial roads out of the city. In time of war these are to be one-way streets. I gather that not only will omnibuses and coaches be used, but private motorists will be allowed to evacuate their own families on condition that they return and act as carriers of their poorer neighbours.

We are apparently to evacuate three-and-a-half million Londoners by railway. If this is done through the termini it will mean appalling congestion there, and they will be ideal targets for aircraft. In fact the situation will be somewhat as follows. There is a state of tension. Herr Hitler (or some other European tyrant) is in two minds whether to make war on Britain. General Goering (or some other believer in victory by mass-murder) learns that the evacuation of London is starting. "You must strike now," he says. "In another week at most England will be far less vulnerable. Once evacuation is over the British bombers will be over Germany. But for the next three days they are intensely vulnerable. If we miss this blow we betray our country." And so on. For it takes a week or so to put on a war censorship, and till then the news could not be kept secret.

The danger would be lessened if, as far as possible, suburban stations on the main lines were used instead of termini for entrainment, e.g. Kilburn, Kensal Green and Willesden instead of Euston. I do not know how far this is practicable during a rush.

The danger of congestion is equally great with road traffic. Our enemies have only to read the various reports made to the Ministry of Transport to know just where to drop their bombs, here on a town such as Staines or Stevenage, there on a cross-roads, or where to attack traffic with machine-guns. Of course, things would be very much better if one-way traffic were instituted. But evacuation by road will not be too safe. The fault lies largely with Mr. Winston Churchill, who as Chancellor of the Exchequer started the policy

of using for other purposes the money raised for the Road Fund by taxation of motor vehicles. A heavy responsibility also rests on the Automobile Association and the Royal Automobile Club, whose members were too "patriotic," i.e. too conservative, to protest effectively against a measure which has made their country a far better target for air attack than would be the case if it had the road system which Mr. Lloyd George intended when he started the Road Fund.

The refugees will be detrained or dismounted from the London buses and coaches at distribution centres outside London, where they will be distributed radially, and presumably the same thing will happen in the case of Sheffield and other large towns. So we come to the next question.

LIBRARY OF
EWING CHRISTIAN COLLEGE

ALLAHABAD

WHERE WILL THEY GO?

Clearly the refugees will not find bomb-proof shelters in the country. The country towns, at least in Eastern England, will be excellent targets, and people will probably be even less safe there than in London as their anti-aircraft defence will be less satisfactory. The only comparative safety is to be found in areas where houses are so far apart that a bomb aimed at one house is unlikely to hit another if it misses its target. This is sometimes the case with a small village. I have known a whole salvo of bombs to miss a Spanish village completely, whereas a bomb dropped on a town never misses it altogether, though it rarely hits the exact object at which it is aimed.

It follows that the refugees should not be billeted in towns, except perhaps in Western England and Northern Scotland, and in Wales. They should be scattered in the villages, and above all in isolated houses. For large groups of children, country houses and isolated hotels are particularly well suited. Large country houses belonging to the well-to-do are rarely occupied to their full capacity. They stand apart from other buildings. So on the one hand a bomber would waste a great many bombs in attempting to hit one, and on the other, trenches could be dug in their neighbourhood. Very often these trenches could be hidden under trees.

A census of such houses within 100 miles of London would, I think, reveal accommodation for most of the London school children, not of course in beds, but sleeping on the floors of the very large rooms which are characteristic of these houses. A certain number of large farms are also suitable for putting up considerable bodies of children. Families, on the other hand, would be better billeted in the smaller houses and cottages. Even so there will not be anything like accommodation for three million refugees from London. Most of them will have to go into tents, and tents are very conspicuous from the air.

The difficulty of housing seven million refugees has not escaped the eagle-like perspicacity of our Home Secretary. On June 1st he said,¹ "Supposing that an evacuation of this kind is organized and that, as I believe, it would inevitably include preparations for evacuating men and women of small means as well,

¹ *Times*, June 2nd, 1938.

then it would seem to follow that steps must be taken to provide shelter and housing accommodation for these people when they go into the country."

Sir Samuel is evidently not quite sure that old men, women, and children need a tent, or even a roof, over their heads during an English winter. I can assure him that this is the case. It would also seem to follow that if he has so far taken no steps to provide such shelter, he should be replaced by someone who will do so.

Here a difficulty will inevitably arise. The Cambridge Scientists' group have worked out¹ a scheme for evacuating many of the population of Cambridge into the surrounding villages. And no doubt the women and children of Reading, Wokingham and Windsor could be scattered over Berkshire, and so on. It would appear however that the people of London will have precedence over local inhabitants. The whole affair will have to be organized nationally, and it seems likely that Londoners will be quite unduly favoured unless some control is exercised by Parliament.

At this point we must consider a proposal put forward, according to a press report,² by Messrs. Golden and Buchanan, both of whom have worked at Geneva on problems concerning refugees. It is likely that we may hear more of this report in the future, as it is to be laid before Sir John Anderson's committee. Some items in it seem to be most unrealistic. For example "it plans convoys of emergency mobile kitchens to travel with thousands of refugees who may evacuate the East End of London on foot if ever there is an air

¹ *Fact*, No. 13, 1938.

² *Evening Standard*, May 27th, 1938.

attack on the docks." No doubt Marshal Goering would also favour any scheme to make the roads of England more attractive to pedestrians during a period of evacuation. It is surely clear that, if East London is to be evacuated, it must be evacuated by trains or motor vehicles. As Mr. Lloyd has pointed out, this is an entirely practical proposition. A crowd on foot, on the other hand, is absolutely uncontrollable, very liable to panic, and moves very slowly, blocking the roads to quicker traffic.

The main scheme deals with the evacuation of three million school children living in the most dangerous areas. The following proposals are made:

"Build now, in country areas which have already been chosen, 600 camp-schools with wooden huts, open-air class-rooms, and sleeping and living accommodation for 500 children (the average size of a council elementary school).

"When the camps are built, foundations, water supply and drainage will be put in to enable them to be extended to ten times the size, accommodating 5,000 children each. The extra huts needed will be stored in sections, ready for erection.

"During peace time, one camp-school will be allotted to ten existing elementary schools. Each school, accompanied by the teachers, will move out in rotation to its camp for one month a year. All the children will thus be accustomed to their own camp-schools.

"It is estimated that each camp-school would cost £20,000 to construct. The total scheme would cost £12,000,000. Against this, a Medical Officer of Health

has stated that a month in the country for all the school children would halve child illnesses, the debilitation resulting from which is said to cost the nation £20,000,000 a year.

"The cost of keeping the children in the camps, schools, in peace or war, would be borne by the local education authorities of their home borough, with a block-grant of 50 per cent from the Government, under existing law."

I am entirely in favour of country schools for children. On the other hand, if they are to be used for ten months of the year (presumably all but January and February) I think there may be complaints from those children who have to spend their August and Christmas holidays at school. But the real criticism is far more serious. We shall, in effect, have 600 small towns of 5,000 inhabitants each. Their inhabitants will be living in wooden huts, which are not only inflammable, but give no protection at all from either splinters or blast. Nor can they be made gas-proof. A case is reported of a wooden hut of the British army hut type in Spain being knocked over by the blast from a bomb 100 yards away. These towns will be quite big enough for targets. That is to say a bomb aimed at the middle will be pretty well bound to hit them somewhere. They will therefore need bomb-proof shelters like any other towns, and indeed more so, because they are less solidly built. Hence if this scheme is agreed to the people must see to it that these camps are provided with not merely splinter-proof but bomb-proof refuges. Otherwise they will be death-traps.

There may still be people in England who believe that they would not be attacked. If so, let them read the accounts of the exploits of German and Italian airmen in Spain. It will also be argued that enemy airmen would not attack them because they would be too busy on objectives of military value.

Let us therefore chronicle a little conversation in the year 1940 between Air-Marshal Wild and Air-Marshal Mild in a bomb-proof shelter in Berlin.

M. "That last attack on Sheffield was a nasty business. Twelve of our 'planes brought down by anti-aircraft guns. We can't go on like that."

W. "Well, you asked for it, didn't you? Our brave airmen died because of your scruples."

M. "I don't agree. But what do you suggest?"

W. "There are two big children's camps near Sheffield, one in Dovedale, and one just off the road to Matlock. If you bomb them the people of Sheffield will insist on having some of their anti-aircraft guns moved out there. Besides, it will interfere with work in Sheffield. The fathers and mothers of the children we kill will feel they have to kill someone. They can't kill us, so they'll go for the Lord Mayor or the Chief Air Warden or somebody. Even if they only demonstrate, they will stop working."

M. "I think it is lowering the traditions of our Air Force."

W. "They killed plenty of children in Spain."

M. "Oh, but they were Reds; and we weren't officially there, anyway. Still, I suppose we shall have to do it. I don't see any other way of dispersing the enemy's defence."

W. "Fine! Now what do you think we use in addition to light H.E. bombs? Shall it be incendiaries or gas?"

Actually this principle is being applied in Spain at the time of writing. Barcelona is bombed partly to cause panic, but partly to keep anti-aircraft guns back from the military area where they are needed to defend troops. No sooner is Barcelona more or less protected than the massacre is extended to such places as Granollers, which are of no military value, but where the survivors will demand protection.

There is another argument against the camp-school plan. This plan would take several years to accomplish. Now I hope and believe that within a year the popular demand for bomb-proof shelters will rise to such a pitch as to force their provision, either by the present Government or more probably by its successor. If so, as the amount of bomb-proof shelter increases, the importance of evacuation will be lessened.

I am not one of those who see evacuation as a real solution. It would involve the most appalling social upset. I do not suppose that a train from London to Penzance (which is only a little further than from Madrid to Alicante) would take as long as in the case which I have described. But it would be at least as crowded. And when the refugees arrived at their destinations there would certainly not be "beds for all who come."

In fact I doubt if all of them would be as well off as those with whom I spent the night of January 2nd, 1938, in Tarancon, on the road from Madrid to Valencia. I had managed, after a long walk through

snow, to get a place on an empty food lorry from Madrid as far as Tarancon, along with another man and a woman. Night fell, and the ground was covered with snow. After an hour or so's search we found a farm on the outskirts with a big dug-out, which was used as sleeping quarters for women and children. I also got a small loaf by telling the authorities that I was a very important person. I slept with about twenty other people in a stable where there were also three mules, which helped to warm the place, and had a pleasant smell. We slept on the straw, and there were even straw-filled sacks as mattresses for most of us. And if there was a raid we could have crowded into the dug-out. My chief complaint was due to the light. An electric wire had been run into the stable, and as there were women as well as men in the stable it was kept on all night, as is usual in loyal Spain. It is not at all sure that every refugee from London would get as good accommodation as this during an English winter. They will find much fewer animals to warm them if they are so lucky as to get shelter in a stable. And they will be fortunate if they get a roof over their heads at all.

The feeding of refugees is of course a big difficulty. The Government "know something about the food problem." But there is no reason to think they have done anything about it. This would involve the accumulation of large food stocks in country areas. It could best be tackled as part of a national scheme for food stores. But further discussion of evacuation is best postponed. For evacuation should be part of a general scheme of national defence. It cannot be considered without reference to other measures.

CHAPTER VIII

AN A.R.P. SCHEME GIVING COMPLETE PROTECTION

IN THIS CHAPTER I propose to put forward a scheme for air-raid protection, such as I believe a Labour or Popular Front Government could carry out if it came into office. In the next chapter I shall give reasons why, in my opinion, a "National" Government could not do so.

I am not assuming that any form of socialism is in being, although I am perfectly aware that the cost of any programme would be less, and the efficiency greater, under socialism. But I am also aware that the Labour Party does not at present propose to introduce socialism in one step. As, therefore, this book is concerned with A.R.P. policy, I shall not assume that any of our great industries have been nationalized. I also realize the difficulties of the situation. Any Government which took National Defence (as opposed to National Offence, which is a very different matter), seriously, would have an immense amount of lee-way to make up.

A programme must therefore fall into two parts. The first part includes schemes which could be carried through in a few months or even weeks, but which are expressly considered as provisional. The second consists of measures which should ensure our national safety

in the event of aerial war for another ten years or more ahead. For the precise nature of the developments of war technique cannot of course be foreseen indefinitely. We may call these the immediate plan and the two-year plan. Besides this some slower developments will be suggested.

A. THE IMMEDIATE PLAN

The details of this plan are not given in their order of importance. I have little doubt that the most important is the digging of trenches.

1. A Minister of Civilian Defence will be appointed. He will be on a par with the First Lord of the Admiralty, and the Secretaries of State for War and Air. He will take over the existing A.R.P. Department of the Home Office, and will also be concerned with such questions as food storage.

2. One of his first tasks will be to overhaul the existing A.R.P. personnel. He will recognize that A.R.P. is very largely a technical problem, and that a civil engineer is better qualified than a retired military officer to direct the Air Defence of a town. Actually a great many engineers have practical experience of war, and many of them have been officers, so it will not be difficult to obtain people with the double qualification if this is considered important.

The towns and villages will be divided up into blocks containing 500 or so people. Two air-raid wardens per block will be elected by ballot after a public meeting of all adults living in the block. I have no doubt that in many cases the existing wardens would

be chosen. They have been partially trained; and they have shown their keenness by volunteering. If an existing warden is rejected this will prove that he or she is not, in the words of the A.R.P. Memorandum 4, "of a type to inspire their neighbours," and is therefore unsuited for the post.

In areas where mass evacuation is planned, one or two evacuation wardens will also be elected per block.

3. The responsibility for the covering of lights in any building will be divided between the owner and the occupants. It will be the landlord's duty to provide blinds, paint, and other materials. These will be supplied by the Government at wholesale prices, and half the cost will be advanced in the form of a loan to be repaid in the course of five years, free of interest. It will be the duty of the occupants to see that lights are covered, and it will be a statutory crime to show them in time of war. The provision of materials is to be completed within three months, and the whole scheme tested under the supervision of the wardens.

Definite regulations regarding lighting of vehicles will be published.

4. The provision of gas protection for babies will be treated as a matter of the first urgency. It will be handed over in part at least to the Army Clothing Department, even if this involves a delay in the supply of full-dress uniforms for the Brigade of Guards.

5. A gas chamber will be set up for every 10,000 people in towns, and everyone will have the opportunity of testing the existing respirators in an atmosphere of tear gas. Children will be taught at school. The question of whether the existing type of civilian

respirator is adequate will to a large extent be decided on the result of these tests. In view of the possibility that an enemy power might make a surprise attack before the respirators at present stored could be distributed, their manufacture will continue until it is possible to issue to the inhabitants of areas considered specially vulnerable (e.g. London, the towns of the Thames estuary, Norwich, Hull, and the North-Eastern industrial area) a respirator apiece, to be kept at home for use in case of surprise, and additional to those stored.

6. A committee of experts nominated by the various parties will be appointed to investigate the question of protection against gas, including that of individual susceptibility to mustard gas, and ordered to report within three months.

7. Air wardens will be supplied with steel helmets, and will not be placed in positions involving excessive personal danger during air raids. During the "rush" period of anti-gas training of the whole population they will be given an allowance for the time spent on duty. Any air warden failing in his or her duties during this period may be dismissed by a two-thirds majority of his or her electors.

8. The expansion of the fire brigades will be continued or even accelerated. They will not however be expected to patrol the streets during air raids. The number of rescue squads will be increased in many areas. Landlords will be compelled to protect their own property under the same conditions as in paragraph 3.

9. Trenches will be dug in all suitable open spaces. Compulsory powers will be secured for digging them

in private gardens and yards where public spaces are not available. Where there is open space available, but the water level or rock level is too high to permit of the digging of trenches, breastworks will be built similar to those built during the war in the waterlogged areas of Flanders, or cast-iron huts of the Nissen or other similar type will be installed.

This will be regarded as a strictly temporary measure, pending the completion of a system of fully bomb-proof shelters. It is recognized that it will result in a temporary loss of amenities. On the other hand the immediate digging of trenches will have two advantages. In the first place it will obviate the effects of a surprise attack. In the second place such trenches will be extremely visible from the air when first built. But they will be very much less so when they have been covered over; and planted with turf where the ground is grassy, made to resemble their surroundings where it is not.

It is also recognized that an enemy would use different methods when attacking a town with trench systems in its parks, as compared with an unprotected town. He would use lighter bombs and more of them, in the hope of obtaining direct hits.

Nevertheless I have no doubt that trenches are very much better than any other type of protection which can be improvised in a short time. When I began this book I felt some qualms as to whether I might not be ascribing an undue value to them. So I am very glad to have official confirmation of my views. "The one subject," according to Mr. Lloyd,¹

¹ *Times*, June 2nd, 1938.

"on which he found complete unanimity among the air raid precaution experts in Germany, France, and this country was the great value of trenches as air raid protection. Everyone who had a garden or easy access to an open space had the possibility of a good shelter available."

That, I take it, is why we are not to be given trenches until the very last moment, but are encouraged to buy sandbags and sticky paper to protect our windows.

10. Some areas are so crowded that trenches cannot be dug, or breastworks built. In some of them steel frame buildings are available, including for example modern blocks of flats in Westminster and Pimlico. Where this is so, compulsory powers of billeting will be applied (see paragraph 12) and persons living in ordinary brick houses will be moved into them on the alarm of war. The standard of overcrowding will be that in force in working-class areas.

In other cases cellars are available. "These are privately owned," said Sir Samuel Hoare,¹ speaking of Holborn, "and I am assuming that in many cases the owners would place them at the disposal of the public in time of emergency." In 1917 and 1918 the owners often refused to do so. Several cases have been brought to my notice. Compulsory powers will be obtained to put these cellars at the disposal of the public. The Government does not "assume that in many cases" able-bodied men will undertake national service in time of war. It proposes to conscript them. But it will not conscript even cellars, much less capital. I can imagine very well what would happen in Madrid

¹ *Times*, June 2nd, 1938.

if the owner of a good cellar refused to allow its use as a public refuge. It would be suggested to him that the lamp-posts had not been in use since 1936, and that in spite of the shortage of rope he would constitute a suitable decoration for one. This would, of course, be another Red Atrocity. Actually no such case has arisen. A certain degree of public spirit is taken for granted in Madrid.

Elsewhere there are strong-rooms and other underground refuges. In such cases the public will be given access, but financial assistance will be given for improvements made before a certain date.

11. Where, as in London, underground railways exist, they will so far as possible be rendered flood-proof and gas-proof, and full instructions will be given as to their use as shelters.

12. Compulsory powers of billeting will be given. All buildings separated by 30 yards or more from another building except in a few "target areas" will be placed in category A. Buildings in the far West of England and Northern Scotland, and in isolated villages of other parts will be placed in category B. Other buildings considered to be safer than those in towns will be placed in category C. Large buildings in category A, including country houses, hotels, and a certain number of churches, will be reserved for school children, and trenches dug in their neighbourhood. For those who cannot be accommodated in buildings, tents will be stored at suitable centres. Compulsory powers will be taken for setting up small camps to contain less than 200 people each, on selected sites.

The evacuation categories will be:

A. Schoolchildren in vulnerable areas.

B. Dispensable adults in those parts of vulnerable areas where trenches or other shelter of like value is not available.

C. Other dispensable adults in vulnerable areas where trenches and the like are available.

13. A place in the country will be assigned to every school, and teachers will make themselves familiar with the buildings to be occupied. Evacuation wardens will have similar duties in connexion with categories B and C.

14. In the case of large cities a scheme for evacuation by rail and road combined will be drawn up. In each case there will be an alternative scheme to put into operation should the railway exits from any particular area be blocked. E.g. if Paddington Station is bombed a group of buses will collect people in assigned areas, and take them off down Great West Road and Western Avenue. There will be rigid control of private cars.

I have not sufficient experience of traffic problems to go into details. Probably the Parisian plan would furnish a valuable model. The general principle involved will be power to commandeer vehicles, rather than any attempt to regiment the whole population. The example of Madrid proves the difficulty of the latter course.

15. Under compulsory powers certain essential road-widening schemes will at once be undertaken. This will involve the immediate demolition of certain buildings. Examples will readily occur to Londoners of buildings on Hampstead Heath, in Kingston Road, S.W.19, and at Staines, which produce bottle-necks

on otherwise useful roads. The existence of such buildings in war-time might involve the loss of thousands of lives.

16. As part of a national food-storage scheme stocks of durable foods, e.g. biscuits and bully beef, will be accumulated in every village where refugees are to be sent.

17. Negotiations will at once be opened with the authorities in Eire and Northern Ireland regarding participation in the evacuation schemes. It will be suggested that Catholic schools might well be evacuated to the former area.

18. In the event of obstruction by the House of Lords, particularly in the case of compulsory powers, the Prime Minister will advise His Majesty to create so many new peers as may be required.

19. The whole Labour Movement will be mobilized behind the scheme, with a view to giving it the broadest possible democratic basis. Its essentially pacific character will be emphasized. It will be pointed out that it is a temporary and provisional scheme, which has only become necessary because the former Government was no more willing to protect British civilians on land than at sea. Much propaganda will be needed to persuade people to consent in advance to be evacuated.

This programme is, of course, not to be regarded as a hard and fast one, particularly where evacuation is concerned. I am sure that a committee of the right experts could improve it in a few hours. In many cases, for example that of hospitals, the fault does not lie so much in the existing schemes as in the fact that they are not being carried out.

The main financial burden would be that of trench-digging. According to Sir Samuel Hoare this could be done in a few days in the event of an emergency. If this is so it could be done in a month without difficulty. The cost would be partly for timber, but largely for wages. And as large numbers of unemployed men would be used, this would partly be counterbalanced by the reduction of the number of unemployed.

The question of personnel is probably more serious. This difficulty would be overcome if A.R.P. were placed on a democratic basis. At present we are not getting enough people for the essential services, and we are not by any means always getting the right ones.

Of course I am aware that the proposal to shift children who are often ill-mannered, and some of whom might import bed-bugs, into the country houses of Surrey, Berks, and Bucks would gravely incommode their owners, whose patriotism has in most cases well-defined limits. Nevertheless it will be pointed out to them that the measure is a temporary one, and that under the Two-Year plan camps will be built for these children, and Lord Astor will once more be able to sleep sound in his bed.

B. A TWO-YEAR PLAN

1. An immediate survey, by borings where necessary, of the subsoil of London and other towns will be begun. The opinion of experts on aviation will be asked as to how far north and west such a survey should extend. A good deal may depend here on the issue of the war in Spain. Penzance is 510 miles from the nearest

aerodromes in Germany in the neighbourhood of Aachen. It is only 460 miles from Gijon, the nearest German aerodrome in Spain. And the direct route from Germany is over Southern England, that from Spain over the open sea.

2. A committee mainly consisting of engineers, and including at least one expert on sewers, will be asked for an immediate report on the costs of various types of scheme. This would have to be based on experiments intended to forestall the "progress" of aerial bombing. Thus so far as I know no two-ton bombs have been used in war. A two-ton bomb with dummy filling would be dropped and its depth of penetration noted. Two-ton bombs at this depth in the soil would then be exploded above tunnels of various materials at different depths. Of course our military authorities may possess this information already. But if so they do not put it at the disposal of the general public.

Armour-piercing bombs contain less explosive than the ordinary type of the same weight, but penetrate a great deal further before bursting. Hence they have very little blast effect, and a great deal of shock effect. It is quite conceivable that a two-ton armour-piercing bomb might penetrate 30 feet of soil before bursting, and then blow in a brick tunnel another 30 feet down. If so the shelters would have to be deeper. Another 20 feet of depth would add about 10 per cent to the cost of excavation and bricks, and about 7 per cent to the total cost. In what follows I shall assume that, at least for most of London, the conclusion is reached that a system of deep tunnels is the most suitable form of protection.

3. A civilian defence loan or a series of such loans will be floated to cover the cost of underground shelters. We may expect a slump, and therefore low rates of interest, in the immediate future. And many people would subscribe to such a loan who would be very loath to subscribe to a loan for armaments. The sum needed will be of the order of £400,000,000, but probably less.

4. The excavations will begin. As we saw, London will need about 1,000 miles of 7-foot tunnel. It may turn out that a rectangular tunnel with an arch gives more room per pound spent, and is equally resistant. It may also turn out that a greater width than 7 feet is desirable or that concrete is better than brick. However, I am taking the figures of Chap. VI which are based on actual experience. Moreover the concrete industry is now in the grip of monopoly capitalism, and for this reason prices are likely to be higher relative to brick than would otherwise be the case.

We shall consider the City and Administrative County of London, with an area of 75,000 acres, and a population (1931) of 4,400,000. To allow for different distributions of population by day and by night, we shall want accommodation for 5,500,000. Obviously this figure is provisional. We shall hope that it is too high, and that the school-children at least will have been got away before the bombs fall. At 7,040 people per mile of shelter tunnel we shall want 780 miles of shelter tunnel. If we aim at a figure of 1,000 people per entrance, we shall want 5,500 entrance passages, probably rectangular, so that three people can walk down them abreast. These

take some weeks to get them fit for hard work. The bricks may be more of a difficulty, but I doubt it.

The only part of this programme which could not be completed within a year or less in the case of London is the provision of adequate filters. While scores of firms make very satisfactory air-pumps, relatively few make activated charcoal, of which vast quantities would be needed. And the pleated paper filters which are used for purifying air on a large scale can only be made by highly skilled workmen. It may be added that when made they will stop smoke very efficiently.

However, I do not regard gas as the main danger. And before the tunnel system was complete there would be respirators for all, including babies. So as a preliminary measure, air would be sucked in through pipes opening about 100 feet above ground level, where gas concentrations would be low. The pumps will of course have to be in bomb-proof shelters, and provided with motive power independent of the electricity supply. Probably heavy oil motors with exhausts through tubes going up independently to ground level would be found best. The complete installation of filters, if it is considered necessary, would take several years.

6. In certain areas concrete shelters nearer ground level may be advisable. It may prove quite impossible to provide Hull with a system of tunnels because the soil is too wet, or Edinburgh because the rock is too hard. Most of London is peculiarly well suited for a system of tunnels, for two reasons. In the first place one generally finds London clay at a depth of less than 20 feet, and almost invariably at 60 feet except in the south and

east. Here we find, overlaying the chalk, the Woolwich-Reading beds, which include some sand. These are not quite so well suited for tunnelling as the London clay, and near the river they may prove to be water-logged in some places. In many parts of south-east London (e.g. Woolwich and Lewisham) and in one or two areas to the north of the river, e.g. at Barking creek, the chalk comes within 60 feet of the surface.

Fortunately the London soil as a whole is not water-logged.¹ In 1820 the water level at Hatchett's Hotel, Piccadilly, was within 45 feet of the surface. By 1912 it had fallen to 210 feet below the surface. Hardly anywhere is the water level within 80 feet of the surface today. This is due to the fact that water is pumped from artesian wells, and that most of the rain goes into sewers instead of the soil.

There are, however, some parts of East London, near the river, where the soil is both porous and water-logged, and tunnelling may be too costly. Here large, low-vaulted reinforced concrete halls will be built near the existing ground level, buried under 30 feet of soil taken from excavations elsewhere, and roofed with 3 feet of cement possibly with a metal backing. Naturally we shall use "vibrated" cement, which is particularly tough. In other areas tunnels of other types will be wanted. For example in a good deal of South-Eastern London we shall go down into the chalk, in Newcastle we shall use the old mine galleries where possible, and so on.

7. It may turn out that no type of subterranean shelter is possible in some areas, and overground

¹ See *Records of London Wells*, Geological Survey Memoir, 1913.

shelters are too costly. Here we shall contemplate wholesale evacuation, and arrangements will be made for this purpose as the number of people to be removed from the great cities is lessened.

8. When our corps of miners has finished with London and the other most dangerous areas, they will do the same further north and west. Ultimately we shall aim at a system of completely bomb-proof shelters for every town in England and Wales, and most of those in Scotland, with evacuation as an alternative in special cases. But Wales, and parts of Western England, will not be fully protected at the end of two years.

9. Before they tackle Cardiff or Penrith, we shall consider the children's camps. The camp scheme of p. 196 will be accepted, but every camp will have a complete set of bomb-proof shelters. All the London children's camps will be situated on chalk downs, ranging through Kent and along the Chilterns to Wiltshire. Every camp will have its system of caves under 60 feet of chalk, and completely bomb-proof.

10. When the plan is complete, we shall still propose to evacuate the children of our big towns in the event of war. Even if they had full protection at home, the psychological effect of constantly running to cover would not be too good. But the evacuation will not be a hurried affair along roads or railways crowded with other refugees. We should, so far as possible, use road transport. Even if there were a raid during the evacuation, the children could get underground before the aeroplanes came if they were in the towns, and

scatter well away from the roads if they were in the country.

11. Certain special cases remain to be dealt with in towns. For example the hospitals will each require its own entrance tunnel, and considerably broader shelter tunnels than the rest of the population, in order that patients who cannot walk may be wheeled underground or taken on stretchers. A special corps of bearers will be wanted at each hospital during the period of air raids. And similar provision will have to be made for infirm and bedridden people in private houses. It may be thought desirable to have more adequate shelters than now exist for art treasures.

Again certain areas are particularly liable to flooding. In these areas the entrances to shelters will be raised well above ground level. It may sometimes be necessary to go up ten feet or so before beginning the descent to the shelters. In many cases the possibilities of flooding the shelter system will be limited both by waterproof doors dividing it into sections, and by pumps.

12. As the shelter scheme nears completion, it will become obvious that the hostile strategy against England will be to starve the population to death, since it cannot blow them to pieces. This is the strategy which is at present (June 1938) leading the Prime Minister's Italian friends to murder British seamen in the Spanish ports.

In the case of Britain this could largely be met by concentrating anti-aircraft guns, balloon barrages, and fighting aeroplanes at the ports. Nevertheless our shipping may be attacked at sea by cruisers (e.g. German cruisers based on the Canaries) submarines, fast

motor torpedo boats, and bombing aeroplanes. Hence large-scale food storage is an essential part of civilian defence. Our Government now realizes this in a half-hearted way, though the British Broadcasting Corporation forbade me to make this suggestion to the public four years ago. They wished me, they wrote, to speak as a scientist, as though science were not concerned with such mundane things as eating.

Supplies of wheat and possibly cheese and raw materials for margarine sufficient to keep our population alive for a year will be stored. This will of course involve the State entering the wholesale food trade on a vast scale, perhaps even as a monopolist. For the food in question will not last for ever, and there will have to be a big annual turnover. The cost, which will run into hundreds of millions of pounds, will be met by a loan or levy.

13. As this plan nears completion the Prime Minister will summon an international conference to discuss the complete prohibition of bombing aeroplanes, pointing out that Britain has now less to fear from this weapon and therefore less to gain from its abolition, than any other country. As a token of goodwill he will in any case reduce the number of British bombers drastically.

14. If this is unsuccessful, the plan will be continued, until every village in Britain either has a completely bomb-proof shelter, or arrangements for instant evacuation to an area where such shelters exist.

Here, then, is a definite scheme. The cost of the defence system may exceed £400,000,000, but can hardly be as much as £600,000,000. That is to say it is about one quarter of the sum which the Government

proposes to spend on re-armament during the next few years. The capital invested in food purchase would be largely of the nature of an investment, repaid either in profits or in cheaper food for the people. I have deliberately made the plan as uncontroversial as possible. Thus I have suggested that it be financed by a loan, instead of a levy on capital, which is entirely possible, but would involve drastic measures to prevent the flight of capital abroad.

Again I have left the question of organization open. Under our present economic system the tunnelling work would be put out to contract. A socialist Government would carry it out through a Government department working in the closest touch with the Trade Unions concerned and with Professional Institutions such as the Institution of Civil Engineers.

In my scheme for London I have made no suggestions as to the utilization of a system of tunnels for peaceful purposes. This has been deliberate, and there are several reasons for it. The first is that the problem of making shelters is so urgent that it cannot be allowed to wait for the report of a commission on underground motorways or railways. If our Governments in the past had shown any foresight the two purposes could, of course, have been combined.

Again road and railway tunnels are much larger than shelter tunnels, and therefore more vulnerable to shock, unless indeed they are given extremely tough linings. I cannot form any reliable estimate of the extra depth or extra lining needed to make a tunnel of the diameter (say) of the Mersey tunnel bombproof. The problem is however perfectly soluble.

A system of underground ways would be of immense value to London. But it would probably cost at least double the amount estimated above. The expenditure would be more than repaid, but not to the community. It would appear in an increased value of land in and round London. If the land were nationally owned, or even if the State received a substantial share of the unearned increment on land values, as was the law for a short time after Mr. Lloyd George's 1910 budget, it would be a reasonable investment. But as things are it would place a burden on the tax-payers or rate-payers for the benefit of landlords.

Hence the most that I can recommend is that some of the shelter tunnels should be straight, and running such a course that they could be enlarged at a later date to form underground ways. In order to allow the completion of 1,000 miles of tunnel in a year, a good many of them would have to branch, and very often the bottom of the approach tunnel would be the meeting point of as many as six shelter tunnels.

I do not doubt that I shall be proved wrong on some points of detail. I do not pretend to be infallible. But I honestly think that I am a good deal more nearly so than the gentlemen who have drawn up some of the official documents on A.R.P.! Above all I have some confidence in two points.

First of all the only practical kind of security against air raids is collective security. It is as ridiculous to expect every Londoner to make his own shelter as to make his own anti-aircraft gun. Once we have got down to a depth of 60 feet or so the cost of the extra shelter for an individual is quite small. But we cannot do

the burrowing individually. Unfortunately our present rulers are opposed to collective security either at home or in the international field.

Secondly the estimated cost is about right. Of course if contractors are allowed to raise prices sufficiently there is no limit to the possible cost. If only as a check on this it will be necessary to carry out a part of the work on socialistic (or more accurately state-capitalistic) lines, as the National Filling Factories were set up during the last war to furnish some kind of check on the profiteering of private concerns. Again I am assuming that the cost of acquiring land will be a small fraction of the whole. Of course there are magnificent opportunities for profiteering in this field. If they are allowed to do so the big shops (to take a single example) will extract a large sum from the Government for the right to cut an entrance to the tunnel system from their basements. And they will then use the existence of this tunnel as an advertising feature.

If we are told that this kind of thing is an unavoidable feature of capitalism, this constitutes an argument in favour of socialism, not an argument against efficient air raid protection. Unless indeed the view is taken that it is better to die under capitalism than to live under socialism. As we shall see in the next chapter, there are quite a number of people who think along these lines.

CHAPTER IX

THE POLITICAL ASPECT OF A.R.P.

EVERY FACT WHICH I have given is perfectly well known to some official in some branch of the Civil Service. Many are known to Sir Samuel Hoare. Why then has no serious action been taken? Why, although the A.R.P. department has been in existence since 1935, and though we have embarked on a colossal re-armament programme, did the Home Secretary wait till May 1938 to appoint a committee "to assist me in arriving at decisions upon the alternatives that we have been discussing" concerning the general policy about evacuation?

There are many reasons, and their effect is cumulative. Some of them would apply to a Labour or Popular Front Government, unless it had a very different personnel from that of the first two Labour Governments. The majority would not. It is only by considering them that we can understand how intimately the political and technical sides of this question are bound up.

BUREAUCRACY

The details of any A.R.P. plan are inevitably in the hands of civil servants. The higher ranks of our civil service are rather strange people. They are highly intelligent, but with a change of Government they may have to use their intelligence for diametrically opposite

purposes. In one year a given man may have to draw up a memorandum showing the necessity of a given piece of expenditure. The Government changes, and next year he produces statistics to prove that it is quite unnecessary. Thus the civil service become experts rather in drawing up schemes than in carrying them out.

They must show a little initiative, but it is safer to show too little than too much. With a sufficient knowledge of laws, bye-laws and regulations, it is generally possible to find good reasons for not taking any particular step. It is much harder to defend yourself for taking one. But the favourite device for blocking any needed action is to produce a very lengthy memorandum showing that it involves a lot of unexpected extra measures. I have produced one myself, so I ought to know. In 1916 a certain general conceived the idea that a German army was going to land in south-western Scotland, and that if so it would use the explosives stored for use in mines there for its own fell purposes. I was therefore ordered to draw up a report on the matter, being at that time a captain in the army, and having been wounded earlier. I could not of course say what I thought of the general. But I drew up a report so long, so detailed, and so complicated that I felt sure that no one would ever read it, and making suggestions so impracticable that I was sure that they would never be carried out. This actually excited the admiration of a permanent official in the Scottish Office, when I explained my motives to him confidentially.

This form of activity is called wrecking (or rather the Russian for wrecking) in the Soviet Union. Having

done it myself here I am therefore the more willing to believe that others have done it there.

The officials of the Home and Scottish Offices rarely have to draw up plans for any great enterprise, but they are very good at drawing up regulations and interpreting those which already exist, and at finding ingenious excuses for the actions of the police. They have very little knowledge of science or engineering.

If such people are put in charge of A.R.P. they naturally consult experts. No expert is asked to go outside his own subject. The gas experts draw up a scheme for protection against gas which would be excellent if gas were the only thing we had to fear. The fire experts draw up a similar scheme. The explosive experts are not so sure of their ground. They hesitate to draw up a complete scheme. It would cost too much. But they do what they can. The civil servants like some parts of these schemes. They involve organizations such as air wardens, and regulations about the divisions of expenditure between different authorities. The most awkward part of the anti-gas scheme is the provision of respirators, which cannot be constructed from paper and red tape. But even that goes forward.

If all these schemes were separate, like a scheme for improving Maidstone jail and another for juvenile courts in London, everything would be fine. But they are not separable. Meanwhile the experts teach other minor experts who descend on the general public. The officials of one hospital were visited in the same month by a gas expert who told them to keep their patients as high up as possible and a fire expert who

told them to keep them as low as possible. The explosive expert had not yet arrived when my informant spoke to me on the matter. The civil servants do what they can to reconcile the reports of different experts, but they naturally plump for those who make the simplest, cheapest, and most definite recommendations, namely the gas experts.

Since civil servants are not in general scientifically or mathematically trained, they fall for quite elementary fallacies, such as the fallacy of dispersion. It is quite possible that they really believe that fewer people will be killed by bombs dropped at random on a given area if people are evenly scattered than if they are crowded together.

The ideal civil servant (from the point of view of every British Government for more than a century back) is an entirely different sort of person from the ideal engineer, who is prepared to plan on a large scale, but is not always either very tactful, or prepared to sink his personal opinions when drawing up a scheme.

It is of the utmost importance to realize that this bureaucratic tradition would equally hamper a Labour or other left-wing Government in any attempt to carry through a comprehensive scheme for civilian defence. If the minister in charge were a man with some knowledge of engineering or science this might not matter. But it would probably be necessary to staff the new department mainly from the ranks of trained engineers, with a few of the old gang to keep accounts and draft regulations. The same will, of course, be true of any other large public enterprises.

HP

In fact socialism will involve the creation of a new civil service, and a fairly complete break with the traditions of the old one.

MILITARISM

There is of course one group of State enterprises to which the ruling classes do not object, though Parliament struggled against them fiercely enough in the seventeenth century. These are the Navy, the Army, and of late years the Air Force. It is important to realize that they serve not only for national defence, but as auxiliary police forces, that is to say as forces for the preservation of the existing social and economic system. In particular a large part of the army is stationed in India, primarily to preserve British rule there. For this reason it is nothing like as efficient as it might be, considering the money spent on it, for the defence of Britain and the British Empire against foreign powers.

Now militarism is the theory that these organizations are good and noble things in themselves, apart from their value for defence or keeping order; and the practice which goes with this theory. Millions of people get a definite satisfaction from the armed forces as others do from football matches and others again from classical music. And partly on account of their value in preserving the class structure of society very great prestige attaches to high rank in these forces. It is felt to be much more glorious to fight than to dig holes. This is not necessarily so. For coal-miners risk their lives constantly, and a great many more

miners than soldiers are killed each year except during major wars. They also show quite as great courage in emergency as soldiers, and have as high a standard of honour.

The result of this is that it does not seem ridiculous to our rulers to spend £400,000,000 in a year on the armed forces, but does seem so to spend this sum on passive defences which would not increase the power, glory, or prestige of a single soldier, sailor or airman.

Even more serious is the effect of militarism on the professional officer class. They learn how battles and campaigns are won, and not how wars are won. I remember hearing a number of British generals discussing the great soldiers of the past. They gave the highest places to Hannibal, Napoleon, and Robert E. Lee, regardless of the fact that each was soundly beaten in the end. The manœuvring of masses of troops is a part of war, but not always the most important part. Other generals, and particularly admirals, realize the importance of technique as regards weapons. But they rarely realize the importance of passive defence. Yet in 1914-1918 passive defence was vital. Good trenches were as important as good rifles. Barbed wire, in the first two years at least, stopped as many attacks as did machine-guns. The German cement "pill-box" was almost as formidable as the British tank. The importance of trenches is of course admitted now. But our soldiers went into the war with entrenching tools less than two feet long, with which they were supposed to excavate holes while lying out in the open in broad daylight under machine-gun fire. At that time our generals

had the excuse that the value of trenches had not been demonstrated. But the value of bomb-proof shelters, and the possibility of making them, have both been conclusively demonstrated in Spain.

CONSERVATISM

Conservatism, in the true sense of the word, is not, of course, synonymous with reaction. It means an attempt to keep things as they are, and to preserve certain things which are worth having. But in practice it generally means a refusal to adapt oneself to new facts, and particularly to new technical developments. The conservative is often willing to accept them up to a point. He may own a motor-car or even an aeroplane, but he will not realize that cars need proper roads, and aeroplanes necessitate either the enforcement of international law or shelters for everyone. Even when this is admitted a conservative is apparently incapable of realizing that other people are poorer than himself, and that this is not a sound reason for condemning them to death.

Thus Mr. Sandys, a conservative M.P. who has seen the effects of bombs on Barcelona, said¹ that "The Home Office should abandon its hesitant attitude and tell the public plainly that, wherever it was reasonably possible, and within the limits of their means, it was the duty of every individual to provide protection for himself and his family. The Home Secretary should also make it clear to local authorities in vulnerable areas that there could be no alternative

¹ *Times*, June 2nd, 1938.

to the provision of public shelters at the public expense."

Let us examine this statement. Supposing I owned a house in London (which I do not) and had about £2,000 to spare (which I have not), I could probably afford to have a steep tunnel with steps driven down to a depth of 60 to 80 feet, ending in a bomb-proof shelter, say for six people. This would not give me as much protection as I could get for £70 to £90 for the same people as part of a collective security scheme. For one thing, unless I had a very large house, or an equally rich neighbour, my refuge would only have one entrance. If this were smashed in by a bomb I should be buried alive. The provision of adequate shelters by private enterprise is entirely outside the means of even the moderately well off.

The provision of public shelters at the public expense is an excellent formula. But let us see how it works out in practice. The cost of shelters will certainly exceed the yield of a penny rate by many times. When a county borough or district council spends an amount involving an increase of more than one penny in the rates, the Government will make a grant amounting to 75 per cent or 85 per cent of the expenditure under the Air Raid Precautions Act. Now the expenditure on shelters is proportional to the number of the population, other things being equal. Thus the expenditure per head will be about the same in different districts. On the other hand the produce of a penny rate is a great deal larger per inhabitant in a rich than in a poor district. Hence the burden will be very unfairly distributed.

The unfairness will best be understood by an analogy. Suppose the Government decided that, since the Army, Navy and Air Force protect everybody, 15 per cent to 25 per cent of their cost was to be raised by a poll tax to which everyone contributed alike, there would be a violent and fully justifiable outcry. This is of course not quite the principle adopted. Actually the greatest sufferers are likely to be the small shopkeepers in the poorer boroughs, who will have to bear a crushing burden of rates.

In the middle ages the naval defence of this country was paid for by the coastal towns. Since the seventeenth century it has been an established principle that Harrogate is under the same obligation as Hartlepool to pay for the Navy; even though a foreign fleet can bombard Hartlepool and cannot bombard Harrogate. I am convinced that the same principle should apply in all forms of national defence.

FASCISM

It must however be recognized that these are not the only reasons why we have no protection. Among the members and supporters of the Government are a certain number of people who are working vigorously on behalf of the continental fascist powers, and have so far worked successfully. It is thanks to these people, for example, that it is a crime to import into Spain the anti-aircraft guns which are needed to protect British shipping in Spanish ports; and that in the event of a war with Germany or Italy, Gibraltar would be untenable, and British communications

with Egypt and Palestine severed, whilst those with India, Australia and New Zealand would be gravely menaced. Some of these people act by spreading false information, for example with regard to events in Spain. Others act very successfully to wreck any attempts to keep the fascist States within the law.

The same people have done their best to paralyse our national defence. For as long as possible the fiction was kept up that Germany was building an aeroplane fleet very slowly. "Where I was wrong," said Earl Baldwin (then Mr. Baldwin) in the House of Commons on November 28th, 1934, "was in my estimate of the future. There I was completely wrong. I tell the House so frankly, because neither I nor any advisers from whom we could get accurate information had any idea of the exact rate at which production could be, and actually was being, speeded up in the six months between November and now. We were completely misled on that subject."

Earl Baldwin did not say who misled him. Lord Londonderry, then Minister for Air, states¹ that "He (Mr. Baldwin) was continually being informed by me, not only of German re-armament in the air, but of the approximate rate of that re-armament." If this is true, it is clear that someone else very close to Mr. Baldwin was deliberately misleading him.

In the same way it is clear that the Government has been, and is being, misled, as to the defence of civilians from air raids. Some people would call such activities treasonable, or at the very best, grossly unpatriotic. But those who carry out such propaganda

¹ *Times*, June 27th, 1936.

invariably regard themselves as patriots. Their point of view is something like this.

"Hitler and Mussolini are salvaging civilization. Their methods are stern, but absolutely necessary. Now it is possible that a vocal minority might lead Britain to the brink of war with these great and good men. The occasion might be a defence of the so-called laws of nations, or a sentimental objection to the bombing of foreign children. In such an event the people must be restrained by terror, if a regard for the fundamental decencies of civilization will not do so. Hitler (thank God) has a strong air force. So long as the people of Britain stand in their present very salutary fear of it they will not interfere with his far-sighted policy of consolidating Europe.

"But if they realized that they were in no personal danger they might be tempted to intervene. In such a case Hitler and Mussolini would probably be unable to bring pressure on Britain, and although there might not be a war, fascism would collapse, and Europe would sink into Red Ruin."

You will not find all these views expressed together. You will find them expressed separately by different pro-fascist writers and speakers. It is very significant that the same writers have combined the very grossest panic-mongering in respect of the gas danger with a profound admiration for Herr Hitler.

Why then, it may be asked, do Hitler's friends support the expansion of the British Air Force? Various reasons are given. A writer in *The Aeroplane* explained the fact that north-western Germany is full of aerodromes on the ground that they are intended

for the reception of the British air fleet during a joint attack on the Soviet Union. By a curious coincidence they are also well suited for the departure of German aeroplanes to bomb Britain.

However, until 1933 the main function of the British bomber was supposed to be "police bombing." In 1933 the British Government was "prepared to subscribe to universal acceptance of the abolition of naval and military aircraft and of air bombing (except for police purposes in outlying places)" subject to certain other conditions.¹ Police bombing means the bombing of British subjects by British 'planes, German subjects by German 'planes, and so on. It has been the British practice to give warning so that only property and not life might be destroyed.

Police bombing is, then, regarded as a very important duty of the Royal Air Force. If this force were not used in a foreign war, it might, according to a certain school of thought, prove very valuable in India or the colonies in dealing with a revolt. Experience seems to show that this is wrong. Bombing of villages after warning has not prevented wars on the north-western frontier of India. Bombing of towns might possibly quell a revolt temporarily. But if the psychological reaction of the Spaniards and Chinese is any guide, it would leave behind it a hatred which would render any permanent settlement quite impossible, and lead to wholesale retaliatory massacres of British civilians in any future revolt.

There is still another aspect of police bombing to be considered. The following argument is sometimes

¹ *Times*, February 21st, 1933.

put forward in conversation, though rarely, if ever, in print. "In the event of civil disturbances in England the Army might prove unreliable. Or if not it might be difficult to move sufficient forces immediately into the disturbed area. In such a case a highly mobile force such as the R.A.F. might prove of inestimable value in the restoration of order. It might be able, by a decisive stroke, to nip the revolutionary movement in the bud, and thus avert much more serious bloodshed."

I have heard middle-aged gentlemen, particularly in clubs, talking along these lines. And one of them, who has since become one of Franco's leading supporters in this country, said that he relied on the Air Force to deal with socialism in England if it ever became a danger. Whether our airmen actually would bomb British towns is another matter, and whether if they did, the rank and file of the Air Force would not wreck their machines is still another.

Nevertheless it is clear that a system of underground shelters would make such a policy quite impossible. Now I am not suggesting that the Cabinet are planning to bomb British civilians. They would dismiss such an accusation with the same scorn as Thiers dismissed the suggestion that the forts round Paris were intended to bombard it. However, the garrisons of these forts did bombard it in 1871 by order of Thiers. And this objection to the provision of adequate shelters is, as a matter of fact, in the back of the minds of some people who have influence in high quarters. And it is one reason, if only a minor one, why nothing has been done to give us shelters.

GUILT

I once asked my late uncle, Lord Haldane, whom he would choose as counsel for the defence if he were accused of murder. "That depends upon whether or not I was guilty," he replied. "If I had done the murder I should certainly choose Sir John Simon." Sir John is one of the greatest living advocates, and the world will long remember his successful defence at the League Assembly meeting in 1932, of the Japanese occupation of Manchuria. This brilliant forensic effort led up to the British refusal to carry out Article 16 of the League Covenant in 1935, and their refusal in 1936 and ever since to allow the Spaniards the anti-aircraft guns and other weapons needed to defend their cities against Italian and German aeroplanes. (For these weapons were being exported to other countries at a time when the British Army was very short of them, so they could have been sent to Spain.)

Now Sir John is a very intelligent man. So is Sir Samuel Hoare. And they know perfectly well that as the result of such actions tens of thousands of innocent people have died in terror and agony. Naturally they do not admit this publicly. Now when people are aware of their guilt and do not admit it they get into a very strange psychological condition, which is well illustrated in the last three acts of *Macbeth*. Macbeth said,

" Things without remedy
Must be without regard. What's done is done."

Generally this process of repression, as it is now called, is not fully conscious. But it is quite effective. It leads, as in Macbeth's case, to worse crimes. In 1935 the National Government refused to help the Abyssinians as they were bound to do under Article 16. In 1938 they refused to help British seamen on their lawful occasions.

However, what concerns us now is their refusal to face the facts of the Spanish war. Not merely the moral facts, but the plain physical facts that incendiary bombs are less effective than was believed, and that it is possible to protect civilians effectively from high explosive bombs. Anyone who has spent an appreciable time in loyal Spain is for that reason considered unworthy of a hearing. If you once begin to draw lessons from Spain you have to admit that the bombs dropped on Madrid and Barcelona are German and Italian bombs, and that therefore the non-intervention agreement is being broken. So the lessons of the Spanish war are not to be applied. This is of course unfortunate for the people of Britain. The bomb-proof shelters in Valencia were mostly built in the summer of 1937. So far as I know the first suggestion that London might copy Valencia in its precautions was made by me in the *Daily Express* in the autumn of that year. It is now fairly generally admitted to be the correct policy; though I think that for most of London, at any rate, tunnels would be cheaper and more effective than concrete shelters. But if the British Government had been willing to take cognizance of events in Spain we should, by now, have bomb-proof shelters for several millions of our people.

There is a justice in history. But it is a very rough sort of justice. The sins of the fathers are visited on the children. For the young men fight in the wars which old men make. And the sins of Governments are visited on peoples. I only hope that the British people will not be punished for what its rulers have done and left undone.

CORRUPTION AND COMMERCIAL PROPAGANDA

Corruption is inevitable when two conditions are fulfilled. Firstly politicians live in a society where people are paid for other things than working. And secondly, they can have a large influence on the unearned incomes of themselves or others. Up till 1914 English politics were fairly clean, from this point of view. Since then the Government has been forced, partly by war and partly by the need of staving off economic collapse, to interfere on a constantly increasing scale in the normal capitalist processes of industry, commerce, and finance. A tariff or a restriction scheme may mean a fortune for some particular business man, and he will naturally do all he can to achieve it, by influencing individual politicians and the press.

A particularly useful method is by paying considerable salaries to Members of Parliament and Peers as company directors. They are paid £600 (and often much more) for attending 8 or 10 annual board meetings, and it is libellous even if true to suggest that such payments have any influence on their voting in Parliament. Actual bribery is rather rare. One does

not hand over money, but "tips" to buy or sell particular shares or commodities. This is not, of course, usually a breach of the law, as bribery is.

Now, when it is a question of national expenditure from which hundreds of millions of pounds can be extracted in the form of profit, corruption is inevitable, generally in the subtle and perfectly legal forms mentioned above. Besides this the industries concerned spend vast sums on publicity. It is perfectly true that aeroplanes are of value for national defence. The aeroplane industry take good care that we are aware of this fact. It is equally true that other things, for example bricks and mortar, are valuable, but we do not hear so much about them.

For various reasons the firms which would reap profits from doing so have been singularly backward in propaganda, either public or personal, on behalf of their products. However, the Cement and Concrete Association is now beginning to take the matter up. Many of the statements in their pamphlets are true and valuable. Others may or may not be true. For example it may be desirable that trenches should be lined with slabs of concrete, which is much more durable than wood, hurdles, or corrugated iron. It may be, on the other hand, that a hard lining exposes the occupants of the trench to a much greater danger if a bomb explodes close to it than does a lining of a more elastic kind. I do not pretend to know the answer, which however could readily be given as the result of experiments costing a few hundred pounds.

It is reasonable to predict that a fairly intensive

propaganda will be conducted during the next few months on behalf of splinter-proof concrete shelters at or just below ground level, intended for people who are out in the streets of London and other large towns during air raids. Of course, these will be very much better than nothing. There may even be propaganda for more solid shelters of the type of which a number exist in Valencia.

There will, however, be no propaganda from commercial sources for shelters made by excavation, which, if the argument of earlier chapters is even approximately true, are a good deal cheaper. They have however the fatal demerit (from the point of view of big business) that a very large fraction of the expenditure on them will go directly in wages. A certain amount of profits will accrue to contractors, and a good deal to the brick industry, if they are brick-lined. From the national point of view they have the merit that their construction would relieve unemployment, and in so far as the money spent on them goes in wages it will be spent at once, instead of being hoarded, as profits are to a considerable extent during a depression. Thus excavation, besides being cheaper, is much more likely to relieve a depression than is concrete construction.

While therefore the brick industry, if the capitalists concerned¹ wake up to the situation, may yet do something to boost the brick-lined tunnel as a shelter, this is unlikely to counteract the propaganda of the cement and concrete interests as things are at present. On the other hand a Labour or Popular Front Government

¹ I own no shares in the brick-making or any allied industry.

would listen to the voice of the Trade Unions concerned, and particularly of the Miners' Federation, provided their officials can be got to realize that the miners who are at present out of work are the potential saviours of their country.

POLITICAL TACTICS

We have seen that the National Government has adopted an almost entirely incorrect line on a vital matter of national defence. I have given what I believe to be some reasons for this line. Readers who do not agree with the analysis of this chapter may yet be convinced of the general correctness of that of the earlier chapters. And in this section all that matters is that, for whatever reasons, the protective measures adopted are technically inadequate. The Opposition parties have attacked them, but until quite recently on what I believe to be the wrong lines. In particular they have attacked them on gas defence, which is their strongest point, rather than on defence against explosives, which is their weakest.

Now no Government will admit that they have been entirely wrong in their policy on a vital matter for some years back. For such an admission carries the corollary that they should resign in favour of more competent successors. It is true that Sir Samuel Hoare's speech of June 1st implied that he realized that he had been on the wrong tack. But of course he did not say so. Had the Labour Party been in office from 1933 onwards it is arguable that their A. R. P. policy would have been much the same as that of the present Government, though I do not personally think so.

In that case the best hope of a satisfactory air defence would be to turn the Labour Party out of office.

It is one of the features of a two-party system that a radical change of policy can only be secured by turning out the party in office. This is sometimes unfortunate, but apparently inevitable. It is particularly so in the present case, because in practice the existing A. R. P. scheme consists to a considerable extent of propaganda for the National Government. "You can be safe against gas, and nearly safe against other things, if only you will do what the Government advises you." Such is the suggestion which runs right through *The Protection of Your Home*. And the Air Wardens are instructed to do all they can to keep people calm, in other words to convince them that they are being adequately protected.

The National Government cannot suddenly reverse its policy and say, "You are in considerable danger. Our schemes so far give you very little protection beyond what you could get in any case by shutting your windows. You may have to clear out of the big towns in a hurry, and if so we don't yet know where to put you. We must start digging at once. Meanwhile don't take the official publications too seriously, though there are some quite sound bits in them." That is the truth, and the Labour Party could, and I hope would, say it if it secured office. But it would be political suicide for the National Government, and rather than lose office they will gamble with the lives of the people as recklessly as they sacrifice those of British seamen.

It is a paradoxical fact that national defence and

offence are almost always more efficient, though generally cheaper, under a Government of the Left than one of the Right. Lord Haldane's re-organization of the army before the last war is of course a conspicuous example of this fact, though the measures here proposed are defensive, whilst his were mainly offensive. The reason is that the parties of the Right mistake militarism for patriotism. And militarism is inefficient. Perhaps the most magnificent example in existence of militarist theory is Fortescue's remark in his monumental *History of the British Army* that the French Revolution ruined the French Army. In fact it ceased to offer assured careers to young gentlemen, and won an unparalleled series of victories. I am so dastardly a Red that I had rather a quarter of a million miners won the next war, or even better, averted it, by digging holes, than that the young gentlemen of the Royal Air Force lost it by bombing the cities of Europe.

CAPITALISM

Most of the reasons so far given for the failure of the Government to provide us with protection are examples of what are called the internal contradictions of capitalism. Capitalism was a brilliantly successful system 150 years ago, when Adam Smith wrote, but it is now ceasing to work. The most obvious example of these internal contradictions is the fact that, on the one hand, research and planning go on for the cheaper and quicker production of food and other commodities, and on the other these commodities have to be destroyed because they cannot be sold at a profit.

In just the same way we make huge numbers of motor vehicles, but not the roads needed for them. Or if we make the roads they are soon so surrounded with factories and residences that we have to go along them very slowly. We make scientific discoveries, but they cannot be published in a form which ordinary people can read, for fear of libel actions by "patent medicine" vendors. This does not make sense from the point of view which is generally adopted by our press, politicians, and teachers, though it is fully intelligible from another point of view.

Just as it is, at first sight, surprising that a business should at the same time work for increased productive capacity and restrict production, so it is only with an effort that we realize that a State can actually use its own machinery to diminish its defensive power. This is what the British State is doing at present. If you suggest that the German guns around Gibraltar could ever be fired at that fortress, you are denounced as a Red. If you state the utter inadequacy of our defences against air raids you are denounced as a panic-monger.

And the reason for this is clear enough. One of the primary functions of the State (many people think the primary function) is to preserve the existing class-structure. And in a time like the present when the class struggle is fairly acute, the interests of the people as a whole (e.g. their interest in the preservation of the mercantile marine, on which their lives quite literally depend) are subordinated to the class interests of their rulers. In fact the existing social structure renders patriotism impossible for those who wish to preserve it.

A WORD TO THE PACIFISTS

A great many people (if indeed they have read so far as this) will say something to the following effect:

"The whole thing is so beastly that we will have nothing to do with it. If we are going to have to burrow underground life won't be worth living. Another war will mean the end of civilization. Let's all die together if necessary. But don't let us surrender to the war spirit by taking any part in Air Raid Precautions."

I respect this point of view. I believe that air-raids are both morally wrong and aesthetically disgusting. Perhaps I should have emphasized their horror more than I have done in this book. But I find it unpleasant even to write about what babies look like when you dig their bodies out of the ruins of a house, or pick them up so terribly mutilated that you wonder whether it would not be an act of mercy to complete the fascists' work by dashing out their brains on the wall, as you would do if they were animals.

Nevertheless, I think the above line of action is wrong. It is never completely sincere. You cannot avoid having to do with war if you live in Britain. You help to pay for it whenever you pay direct or indirect taxes. So a consistent and absolute pacifist would be permanently in jail. You don't like the idea of going underground. But whenever you burn a coal or coke fire or use gas or electricity you are helping to ensure that the best part of a million coal-miners should go underground every day. Another war would not necessarily or even probably mean the end of

civilization, even if it meant the end of London, Paris, and Berlin. It might lead to a radical change, either for the better or the worse. And we should not all die together. Probably less than one person in twenty would die in most places. The others would live on, very probably a poorer and beastlier life than they do now.

If you are sufficiently brave (and some pacifists are brave) you may be brave enough to walk to and fro in the streets during an air raid without a respirator. And you may do this without hurt if you are lucky enough. But if you do anything else you are to that extent surrendering to the war spirit. Even if you are prepared to do this, are you prepared that children should do the same? Would you not send a child indoors if you found it in the street during an air raid? And if so, would it not be better if you could send it into a bomb-proof shelter, and still better if you could send it into the country?

So long as we have no passive protection two things are inevitable. In the first place the partisans of the short war or knock-out blow theory in the fascist countries will have a plausible case. They will persuade themselves, and perhaps the dictators whom they serve, that Britain can be defeated within a month. This may not be correct. The same people certainly calculated on a short war in Spain, and probably in China. They were wrong. But the fact that they were wrong did not prevent them from attacking Spain and China. Hence an adequate system of bomb-proof shelters will guarantee the world against a war started on this theory.

Secondly, as long as we have no adequate shelters the Labour Party, and other groups who are fundamentally opposed to vast war preparations, will be in a dangerous dilemma. At the present time the Labour Party dare not oppose expenditure on bombing aeroplanes in any effective way because if they did the National Government propagandists would say that they were leaving the country defenceless. And some members of the Labour Party may genuinely believe this. Actually the exact opposite is true. In the words of Mr. Duff-Cooper,¹ "We are no more prepared than we are as individuals against murder." And we shall be no more prepared for anything but counter-murder if we have 10,000 bombing aeroplanes. Hence until we can get underground we shall always be at the mercy of the militarists who demand more offensive weapons. This fact is perfectly well-known to the militarists, and is no doubt one reason for the refusal of our Government to undertake adequate defensive measures.

Yet from the point of view of any patriot, whether or not he is a lover of peace, the country is largely undefended against air attack until shelters are provided. To build an air fleet and no shelters is like building battleships with no armour, or sending an army into the field armed with the latest artillery and machine-guns, but with no spades for digging trenches.

At this point some pacifists will say that I have given my case away, and that I am really only a rather clever militarist trying to inveigle the parties of the Left into helping in preparations for the next war. I deny this. Pacifists can only win by persuasion, not

¹ See p. 79.

by force. At the present time they have not, as a matter of hard fact, been able to persuade the Labour Party to vote against rearmament. And they are unlikely to be able to persuade a majority of voters that the present British rearmament programme is wrong until it is generally realized that there is a method of protecting our people against air raids other than the threat of reprisals. Until we have a system of bomb-proof shelters it is inevitable that many people will believe Earl Baldwin's words, spoken in the House of Commons on November 10th, 1932, "I think it is well for the man in the street to realize that there is no power on earth that can protect him from being bombed. Whatever people may tell him, the bomber will always get through. . . . The only defence is in offence, which means you have to kill more women and children quickly if you want to save yourselves."

It has been one of the chief aims of this book to show that Earl Baldwin's statement is not only morally wrong, but technically wrong. Lovers of peace often make the disastrous mistake of refusing to study the technique of war because they regard it as wicked and disgusting. This is as if a surgeon refused to study cancer because it is a horrible disease.

The same sentimental objection will be brought against my proposals. Some readers will say that they would rather die than go back to the days of the cave men. The answer is that we are living in an age where morality, at least in international affairs, has fallen to a level which the cave men would very probably have condemned. If we build the shelters which I propose we shall very probably never need to use them.

If we do not do so we may very well find ourselves cowering in trenches and cellars which give us no protection against direct hits.

Once we have got rid of the burden of fear which hangs over us at present, the pacifist arguments will find a far readier hearing. And that, of course, is one reason why our militarists refuse to give us the shelters which we need.

Certain pacifist writers are severely to blame for our present terror of air raids. They have given quite exaggerated accounts of what is likely to happen. I have given actual and probable figures in Chapter II. Frightened people have not the courage needed to disarm, or even to think clearly about disarmament. Fear does not generate reason, but hatred. What Browning¹ wrote about Verona six centuries ago is substantially true of Europe today.

"Fear had long since taken root
In every breast, and now these crushed its fruit,
The ripe hate, like a wine; to note the way
It worked while each grew drunk! Men grave and grey
Stood with shut eyelids, rocking to and fro,
Letting the silent luxury trickle slow
About the hollows where a heart should be;
But the young gulped with a delirious glee
Some foretaste of their first debauch in blood."

I wish that every lover of peace would read this passage before quoting Earl Baldwin's statement that "the bomber always gets through." For we too are hardly likely to avoid hate so long as we cannot avoid fear.

¹ "Sordello," Book I.

If we in Britain dig shelters, the other nations will be bound to follow suit. And if this occurs the bombing aeroplane will become an ineffective weapon for the terrorization of civilians, even if it is kept for use in war as a kind of long-range artillery to harass transport behind the line of battle or to destroy munition factories.

We could whole-heartedly welcome measures of this kind in foreign countries. I will go so far as to say that Britain would actually be safer if every German city had bomb-proof shelters for its whole population. It would no longer be possible to frighten the German people into supporting an extreme form of militarism by the threat of bombardment by French, Russian, or British aeroplanes. And the cost of bomb-proof shelters, in Germany as in England, would to a considerable extent come from funds which would otherwise be devoted to making bombing aeroplanes. For it is fairly obvious that the finances of every European state are already strained to the breaking point. A. R. P. can mean Air Raid Precautions or Astronomical Rearmament Profits. It cannot mean both.

The cost of shelters will no doubt be considerable, even if, as I believe, it will only be about a quarter of what we are to spend on offensive rearmament. The sum in question could have been spent on rehousing the people if we had elected a Government which was willing to support international law. But it will not be recurrent expenditure, whereas the bombers which we are building today will be out-of-date in five years and wholly useless in ten. So long as we are frightened of enemy bombers we shall go

on building them ourselves, and any serious expenditure on social reconstruction will become more and more impossible.

There is a way out of this apparently hopeless situation, and that way is not by individual action. We are all parts of society. We cannot escape from it. If society is bad, we cannot help being bad. The only ultimate way out lies in a thorough-going reconstruction of society. But a necessary and indispensable preliminary to this is collective action to safeguard our lives from the menace of air raids, a menace which is generating such terror as to destroy our national sanity.

For this reason I believe that pacifists should collectively agitate for effective shelters. And individually, by becoming Air Raid Wardens, they should help to transform the Air Raid Services from the propagandist bodies which they are in some areas into genuine life-saving organizations.

So long as civilian populations are unprotected, criminal States will continue to murder the citizens of their weaker neighbours and to blackmail the stronger. By ending this possibility we can help to bring about a state of affairs where international relations rest on law rather than force, on reason rather than terror.

CHAPTER X

SUMMARY

AN ACCOUNT is given of recent developments of air warfare against civilians. The main killing weapon in Spain has been the high explosive bomb. Its action is described. Gas and incendiary bombs are subsidiary dangers. The same would be true if Britain were attacked. A considerable measure of protection has been given to civilians in Spain by digging underground shelters.

After a brief chapter on defensive measures of a military kind, such as anti-aircraft guns, the British measures of passive defence are examined. The "black-out" precautions, though good up to a point, are shown to be inadequate because many people cannot afford the necessary materials for screening lights in their houses.

Gas-protected rooms, though far from gas-proof, are very much better than nothing. No individual protection against gas is available for babies. The existing respirators could not be issued instantly if an undeclared war broke out. They would be inefficient not so much because of their inferior quality as because people do not know how to use them. A scientific committee should be set up to arrive at the truth on these matters.

The public precautions against incendiary bombs in the shape of extra fire brigades are good, except

that fire patrols should not be on the streets during an air raid. The private precautions (shovels, sand, pumps, etc., in individual houses) will only be carried out if the cost falls on the landlords (with a State loan if necessary). They are beyond the means of most families.

The precautions so far suggested against high explosive bombs are useless. If trenches are not dug till the danger of war is imminent, they may be dug too late. The policy of encouraging people to strengthen their own houses is unpractical. Against air raids as against war, we need collective security.

The Air Raid Wardens are being given an impossible task, and exposed to unnecessary dangers. Their main function appears to be propaganda in favour of an unworkable scheme. The rescue parties are hopelessly inadequate in numbers. The hospital organization is unworkable on Sir Samuel Hoare's own confession.

The only scheme for evacuation at present known to the public is one for unorganized evacuation by those who can afford it. This will give rise to grave discontent, and may lead to blocking of roads, and raids on traffic by enemy airmen. The policy of dispersal within dangerous areas is strongly criticized.

The various existing types of bomb-proof and partially bomb-proof shelter are described, with special reference to current practice in Spain. Stout cellars and steel frame buildings are greatly preferable to ordinary houses. Trench systems give protection against everything but direct hits. Shallow concrete and other dug-outs are little better than trenches, and far more expensive. The advantages and disad-

vantages of using underground railways are discussed. Systems of brick-lined underground tunnels have proved their value in Spain. The cost of such systems in the London area, based on the costs of a recent sewer scheme, work out at about £10 per head, with an addition of £2 10s. for a ventilation plant which would filter poisonous gases and smokes out of the air supplied. The other efficient type of shelter is a concrete cellar with some 20 feet of earth above its roof, surmounted by 3 feet of cement to burst bombs falling on it.

Evacuation is described as it actually occurs in Spain. The problem is then treated in detail. It is suggested that school-children should have priority in evacuation, and should so far as possible be billeted in large isolated buildings in the country. Mothers with babies and old and infirm people should form the second wave in an evacuation. The difficulties of transport, housing, and feeding are discussed.

A scheme for Air Raid Protection to give complete safety from bombs to about three quarters of our population is described. Its cost is about £400,000,000. It falls into two parts, one to be operated at once, whilst the other would take two years to accomplish.

The most important points in the immediate schemes are the digging of large temporary trench systems in open spaces, including private gardens and yards, in our cities, and arrangements for the evacuation and billeting of school children. Steel frame buildings, vaults, strong-rooms and the like in towns would be taken over. Arrangements would be made for instructing the whole population in the use of respirators.

The two-year plan centres round the construction of bomb-proof and gas-proof shelters for the whole population of our large cities. In London the shelters would consist of 1,400 miles of brick-lined tunnels at a depth of about 60 feet, with entrance tunnels sloping down to them, and a system of ventilation which would ultimately render them gas-proof. The school-children would be evacuated to a system of camps, each with its bomb-proof shelters attached. A scheme for a large national food reserve is an essential corollary.

The political aspects of A. R. P. are discussed. The reasons for the failure of the National Government to produce an effective scheme are analysed. The book ends with a plea to pacifists to co-operate in an efficient scheme, which would render impossible the present terroristic activities of fascist States, and would be an important step in the direction of World Peace.

Four appendices deal with details of the action of gases, and of protection against them.

I have to thank a number of friends for putting their knowledge at my disposal, and more particularly Mr. Pinckheard, A.R.I.B.A., Mr. Skinner, A.R.I.B.A., and Mr. Ryerson. I would add, however, that none of these gentlemen is in any way committed to the conclusions at which I have arrived.

APPENDIX I

POISONOUS GASES AND SMOKES

THIS APPENDIX IS not meant for the general reader, but I shall try to make it as readable as possible by reducing technical details to the necessary minimum.

The substances which, when dispersed in the air, may kill men, can be classified into the following groups by their physical properties.

1. TRUE GASES, which cannot be liquefied at ordinary temperatures by compression. Example, carbon monoxide (CO). These gases are not used in war, because they are not deadly enough.

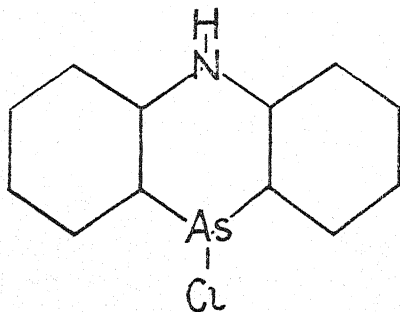
2. Vapours of substances which are liquids at ordinary temperatures, either under atmospheric pressure, or at a pressure of a few atmospheres, and which boil below 150°C . These are generally described as *non-persistent gases*. Examples: Chlorine (Cl_2), boiling point -34°C . Phosgene (COCl_2), boiling point 8°C . Trichlor-methylchloroformate (Diphosgene,¹ Surpalite) ($\text{Cl}-\text{COO}-\text{CCl}_3$), boiling point 128°C . Chloropicrin (NO_2-CCl_3), boiling point 112°C .

3. Vapours of substances which are liquids or solids at ordinary temperatures, and boil at over 150°C . These are described as *persistent gases*. Examples. $\beta\beta'$ -dichlorethyl sulphide (Mustard Gas, Ypérite, Gelbkreuzstoff, $\text{Cl}-\text{CH}_2-\text{CH}_2-\text{S}-\text{CH}_2-\text{CH}_2-\text{Cl}$)

¹ This name is due to the fact that one molecule of it breaks up into two of phosgene on heating.

boiling point 217°C . β -chlorovinyldichlor-arsine (one of the components of Lewisite, $\text{CHCl}=\text{CH}-\text{AsCl}_2$), boiling point 190°C .

4. Substances which are solid at ordinary temperatures, but which can be dispersed as a *smoke*. A smoke, of course, consists of solid (or sometimes liquid) particles, which though small (diameter 10^{-4} to 10^{-5} cm) contain many million molecules each. They are generally destroyed by an attempt to boil them. Examples. Diphenylarsine cyanide $[(\text{C}_6\text{H}_5)_2-\text{AsCN}]$, boiling point 300°C . Diphenyl-amine-arsine chloride (Adamsite,



boiling point 410°C .)

5. Poisonous *dusts*, such as silica and lead dusts, which kill many people in industry. They have not yet been used in war.

These substances can also be classified according to their physiological action as follows:

1. PARALYSANTS. They produce unconsciousness and death without any marked pain or irritation. Examples, Carbon monoxide (CO), hydrocyanic acid (prussic

acid, HCN). They are not used in warfare because a very high concentration is needed. For example a few breaths of hydrocyanic acid in a concentration of one part in 1,000 of air by volume are instantly fatal. But air containing one part in 10,000 can be breathed for hours with no ill effect.

2. ACUTE LUNG IRRITANTS. These gases have a slight effect on the eyes, but they kill by injuring the lungs, causing the membranes to swell and give off fluid, so that oxygen cannot be absorbed, and death occurs for the same reason as in ordinary pneumonia. While the gas is being breathed there is coughing and distress. Then the man may feel better. Within a few hours pulmonary oedema develops and most of the fatal cases die within 24 hours. Those who survive for five days generally recover completely, though convalescence lasts for months, and some become permanent invalids.

The effect of a gas depends both on the concentration breathed and on the time for which it is breathed. In the case of lung irritants it is very roughly proportional to their product. Thus if 50 parts per million by volume¹ of phosgene will kill a man who breathes it for 5 minutes, then 5 parts per million may be expected to kill a man who breathes it for 50 minutes. (These figures are only approximate, but give a rough idea of the toxicity.) With smaller values of the concentration-time product, e.g. 10 parts per million for 5 minutes, serious illness will be caused, but death is rather unlikely.

¹ This is equivalent to 200 milligrams per cubic metre, or about one ounce in 5,000 cubic feet.

Phosgene, chloropicrin, and trichlor-methyl-chloroformate are about equally deadly, though chloropicrin is the least fatal and the most irritating to the eyes and nose.

3. LACHRYMATORS. This need not concern us here. They were used to some extent in 1914-1918, but would not be used in air raids. It must of course be remembered that other gases affect the eyes.

4. SENSORY IRRITANTS. The most effective of these are smokes consisting of particles of arsenical compounds such as those mentioned above. When breathed they cause intense pain in the nose, throat, and chest, with sneezing, vomiting, and appalling misery. A man may go mad and attempt to commit suicide or burrow into the ground.

A concentration of one milligram of diphenylcyanarsine per cubic metre of air (or one ounce in a million cubic feet) will incapacitate a man when breathed for a few seconds. Adamsite appears to be even more powerful in its action. On the other hand the fatal dose is thousands of times greater than this, and no British soldiers are known to have been killed by such substances in 1914-1918. The vast majority of casualties recovered in twelve hours or even less.

For this reason the military value of these smokes consists in the fact that they will penetrate some respirators which will keep out gases. If they do so the sneezing may cause a man to remove his respirator, or at least to shift it so that it leaks. He is then poisoned by gas if this is liberated along with smoke. The green-cross-2 shells, used by the Germans in 1917

and 1919, contained diphenyl-chlorarsine (an arsenical smoke) along with phosgene and diphosgene. Blue-cross shells contained diphenyl-chlorarsine only.

Now an enemy aeroplane could not be sure of dropping a bomb containing phosgene and another containing an irritant smoke in the same spot. But it could drop a bomb analogous to a green-cross-2 shell, liberating a mixture. The irritant smoke from such a bomb would hardly penetrate the more expensive types of respirator, but it might perhaps penetrate the civilian type to some extent. If sensory irritant smokes are used against civilians, it is therefore probable that they will be used in this way.

5. VESICANTS, or blistering substances. The most effective of these are "mustard gas," and Lewisite. The latter is a mixture of β -chlor-vinyl-dichlorarsine ($\text{CHCl}=\text{CH}-\text{AsCl}_2$), $\beta\beta'$ -dichlor-divinyl-chlorarsine [$(\text{CHCl}=\text{CH})_2\text{AsCl}$] and $\beta\beta'\beta''$ -trichlor-vinylarsine [$(\text{CHCl}=\text{CH})_3\text{As}$]. These are oily substances, of which the effects of mustard gas are the best known.

It has a slight and not unpleasant smell like that of mustard. The nose is soon fatigued by the smell, and if a respirator is not instantly put on when it is first smelt the danger from it may be ignored. The vapour acts on the skin, and still more effectively on moist and delicate membranes, such as those of the eyes, throat and lungs. The effect is very like that of a burn, but it is delayed for anything from two to forty-eight hours after the first exposure. The skin becomes so red that the condition has been mistaken for scarlet fever. Blisters later develop, but there is rarely much pain provided the blisters do not get

infected. The skin burns are never fatal, and most cases are completely cured in a few months.

The eyes are particularly sensitive, and become extremely inflamed and painful. Nevertheless, only 10 cases out of 160,000 British casualties were partially and four totally blinded. A few others became blind later on as the result of injury to their eyes by mustard gas.

The main danger is to the wind-pipe and lungs. The gas causes bronchitis and broncho-pneumonia which are often fatal. The maximum mortality occurs on the fourth day, but those cases who survive a fortnight very rarely die, though a few are permanently affected.

Individuals vary greatly in their susceptibility to mustard gas. Some men blister if their skin is exposed for five seconds to air saturated with it. Others do not do so after five minutes. Negroes are particularly resistant. All volunteers for air raid precaution work should be tested for susceptibility. It would be folly to place a susceptible man in charge of decontamination work. So far this obvious precaution does not seem to have been taken in Britain.

It must be emphasized that against an unprotected population such as that of Abyssinia mustard gas is a cruel and terrible weapon. But against one protected with gas masks it is the most humane so far invented. Of 113,764 British casualties from gas in 1918 only 2,672, or 2.3 per cent (1 in 43) died, and about the same proportion were invalided for over 6 months. The proportion killed and invalided by bullets and shells was vastly greater. About 25 per cent of those hit were killed.

Mustard liquid was generally mixed with about 20 per cent of some organic liquid of lower boiling point to enable it to evaporate more quickly. But even so, when spilt on the ground, it remained for days or even weeks, until it disappeared, either by evaporation or by chemical reaction with water. The concentration of the vapour in air which is saturated with it at 15° C. is only about 1 part in 15,000 by volume. In actual practice the concentration in air is always much less. However, 1 part in a million can do considerable damage in an hour, though it is probably rarely fatal.

Hence if people *immediately* leave a contaminated area, they are unlikely to be much hurt by exposure to the vapour for a minute or two. This will be possible if the air-raid wardens know their jobs and enjoy the confidence of the people entrusted to their care.

Lewisite has no smell when pure, but the impure substance has a smell of geraniums. The vapour irritates the nose and eyes at once, so it is easy to detect. A respirator gives complete protection to the eyes, but the skin can be blistered. The blisters are rather more painful than those of mustard gas.

PHYSICAL PROPERTIES OF A GAS-CLOUD. Every student of chemistry learns that a heavy gas such as chlorine can be poured from one vessel into another almost like water, whilst a light gas such as hydrogen rapidly rises. Now all the poisonous gases and vapours used in war are heavier than air, so it is thought that they would inevitably flood cellars and underground shelters, and that on the first floor of a house one would not be safe.

It is true that pure phosgene is about $3\frac{1}{2}$ times as heavy as air. So in the immediate neighbourhood of a big bomb burst it would tend to sink. But within a short time it would be mixed with many times its volume of air. Now air containing one part in 10,000 of phosgene is extremely poisonous. But its density exceeds that of air by only one part in 4,000. Now an increase of density of this amount is secured if air is cooled down one eighth of a degree Fahrenheit.

So once the gas has dispersed, the question where it will go depends on the wind, and on local air currents determined by temperature. If liberated from a bomb with no bursting charge of explosive it may be a little cooler than the air around it. The question whether or not it will penetrate a cellar will be settled mainly by the pre-existing air currents. This matter is dealt with in Chapter IV.

APPENDIX II

GAS-MASKS, AND GAS-PROOF BAGS FOR BABIES

THE EARLIEST GAS-MASKS made in 1915, relied on chemical means to stop chlorine, which was the first gas used. A cloth soaked with sodium phenate or various other compounds will stop chlorine on its way through. But it would not stop carbon monoxide, mustard gas, or many other gases. The terrible prospect arose that it would be necessary to devise a new chemical to stop each new gas. There would be a continual series of surprise attacks with different gases, each successful until a remedy was found, and each involving the death of thousands of men.

It is a most fortunate fact that the majority of vapours can be removed from air, not by chemical combination, but by a process called adsorption, which is non-specific. For example lime will stop an acid gas such as carbon dioxide, and woollen cloth soaked in acid will stop an alkaline gas such as ammonia. No single chemical will combine with both.

But charcoal, silica, and various other substances, when properly prepared, will take up vapours of different chemical types. The molecules form a very thin liquid layer on the surface of the adsorbent, as indeed they do on glass or metals. But charcoal is full of pores and has an enormous surface per unit of weight; so it can take up a great deal of gas.

The main characteristic in a vapour which renders it adsorbable is that it should be the vapour of a liquid with a high boiling point. Thus carbon monoxide boils at -190° C, and is hardly adsorbed at all. Phosgene boils at 8° C and is fairly easily adsorbed. Mustard gas boils at 217° C and is very easily adsorbed indeed. This has a lucky consequence. It is quite sure that there are no unknown poisonous gases with a boiling point as low as that of carbon monoxide. For only a substance with very small molecules can have so low a boiling point. And chemists have made all the possible types of very small molecules. It is unlikely that there are any unknown poisonous gases with as low a boiling point as phosgene, though it is just possible. But if there are they will probably be stopped by charcoal. There may very possibly be some vapours of high boiling point more poisonous than mustard gas. But if so I am prepared to bet a thousand to one that charcoal will stop them all.

So activated charcoal will stop all poisonous gases except a few light ones such as carbon monoxide and hydrogen cyanide. And these latter are not very poisonous.

It is a curious fact that smokes are much harder to stop than gases. The reason is as follows. The molecules of a gas are moving very quickly, even when the gas as a whole is at rest. That is why such a small weight of gas occupies so much space. For example a molecule of phosgene at 60° F has an average speed of about 600 feet per second, though in an extremely zig-zag path, with many thousands of angles per inch; while a particle of an arsenical smoke has an average speed

of a fraction of an inch per second as a result of its collisions with air molecules. So on its way through a box full of fairly coarse grains of charcoal perhaps a tenth of an inch long a phosgene molecule is almost certain to hit one of them, whilst a smoke particle will probably not do so.

On the other hand most smoke particles, including those of the arsenical smokes, will stick to almost any solid which they touch. So smoke can best be filtered through a fabric with fine pores, such as felt or porous paper, or through a pad of cotton wool. So a respirator which is to stop gas and smoke contains both a filter for smoke and a box of charcoal for gas.

The charcoal offers no great resistance to air going through it, because the interstices between the grains are large. But a fabric does so if it is woven closely enough to stop smoke. Now if the same amount of air per minute is sucked through 5 square inches of felt the resistance will be 10 times as great as if it were sucked through 50 square inches. So the army respirators have a large area of smoke filter. The civilian respirators have a filter of smaller area which is not so efficient, and offers more resistance. Besides this, the military respirator has a corrugated rubber tube which is somewhat elastic, so that even a violent gasp for air does not create a great deal of suction.

In consequence a soldier can run in his respirator without too great a resistance to his breathing, and without creating so much suction (negative pressure) in his respirator as to make it likely to leak. The civilian

respirator is designed to give enough air for a man at rest or walking gently. But if the breathing is greatly increased three things happen. The resistance is unpleasant. The powerful suction may cause leakage. And the filter is less efficient against smoke when a large air current is drawn through it.

I am fairly confident in the efficiency of the civilian respirator in almost any gas concentration. It would not however be much use if a phosgene bomb actually burst inside a room. In this case the room would soon contain more phosgene than air, and instant flight would be the only possibility. But a person wearing it would be safe in a concentration of one part in 10,000 of phosgene, of which a very few breaths would otherwise be fatal. And against mustard gas it is even more efficient than against phosgene.

Its efficiency against smoke is less certain. The Cambridge Scientists' group have shown that it lets through tobacco smoke. On the other hand it seems to be proof against poisonous types of smoke except in very high concentrations. And it is worth remembering that although these smokes are most painful and demoralizing, they are not known to have killed anyone in the Great War. Still it is far more likely that a hostile nation has produced or will produce a smoke which will go through the civilian respirators than that they will produce a gas with this property.

The real danger to wearers of respirators is of quite a different character (see p. 105). It is that they will not fit adults, and that small children may find them intolerable. Both these possibilities can be dealt with by organization and training. The outlet for air from

the civilian respirator is between the face and the edges of the mask. So these cannot be completely tight. Nor must they be too loose.

PROTECTION FOR BABIES. It is doubtful if children under four can be got to wear masks. Certainly normal children under two cannot, though perhaps very young babies can. But young children can be protected, and indeed more completely than adults. For they can be put inside a bag or box, and their delicate skins are thus protected against blistering gases.

The bag or box has a celluloid, mica or safety glass window, so that the mother can keep an eye on the baby. One type of container is a closed perambulator, another is a bag in which a small mattress can be placed. There are two ways of ventilating the container. An adult may wear a respirator with an outlet tube passing to it, so that the baby gets the adult's expired air. This is harmless, as the oxygen in expired air is only reduced from 21 per cent to about 18 per cent, and some fresh air will be mixed with it. The oxygen in air breathed can fall to 14 per cent without danger. And the small amount of carbon dioxide in expired air is also harmless. However, the baby may get uncomfortably, or even dangerously, hot. The other method of ventilation is by a pump which forces air through a filter. This is probably the more practical of the two. The simplest type of pump is probably a foot bellows like that of a harmonium. However, in case it is necessary to carry the baby a bag like that of a bagpipes, opening by a spring after it has been squeezed, is preferable.

Whichever type is used the baby is under a slight positive pressure, and even if the bag develops a small leak no poisoned air will leak inwards. In fact if these apparatus are made available and properly used, babies will be rather safer than adults. But the adult working the pump will need very definite instructions. Too slow an air current may make the baby pant, if it does not actually suffocate. And too fast a current may overtax the capacity of the filter. Further the baby may be suffocated if the adult is killed or wounded. So babies should not be put into these apparatus until the need is obvious.

APPENDIX III

CALCULATIONS REGARDING LEAKAGE INTO AND OUT OF ROOMS

A TYPICAL CALCULATION is as follows. Room *E* had a volume of 18,000 cubic feet. One gramme of paraffin candle produces 0.058 cubic foot of CO_2 measured at 60°F and 29.9 inches of barometric pressure. Candles were burning in this room at the rate of 129 grammes per hour, thus producing 7.5 cubic feet of CO_2 per hour. The temperature was 13.5°C .

The air originally contained 3.0 volumes of CO_2 per 1,000. After 3.5 hours it rose to 10.6 parts. Four later analyses, made at intervals during 2.7 hours, gave 10.3, 10.3, 10.6, and 10.1 parts per 10,000. Thus the amount was practically constant, averaging 10.4 parts per 10,000, and was the same near the roof as near the floor; therefore 7.5 cubic feet of CO_2 were leaking out per hour. These were contained in $\frac{7.5 \times 10,000}{10.4}$, or 7,380 cubic feet of air. Thus 7,380 cubic feet out of 18,000 leaked out per hour and 18,000 cubic feet would leak out in 2.44 hours.

Of course this does not mean that in 2.44 hours all the air in the room would leak out. It would be equally accurate to say that 0.68 per cent of the volume of air in the room would leak per minute. At this rate, assuming thorough mixture, which occurred, as was

shown by making analyses at different places, one half of the air in the room would be replaced by external air in 1.69 hours. This calculation is made as follows. Let t be the time, measured in hours. Let x be the fraction of the original air left in the room. Then the rate of decrease of x is by 0.68 per cent per minute, or

$$\frac{dx}{dt} = -kx \text{ where } k = \frac{1}{2.44 \text{ hours.}}$$

Hence $x = e^{-kt}$, and $x = \frac{1}{2}$ when $t = \frac{\log_e 2}{k}$ hours.

$$= \frac{.693}{k} \text{ hours.}$$

Let us now calculate the rate at which poisonous gas will enter a room for which the constant k is known. Suppose the gas concentration outside is 0 until $t=0$, and is then a from $t=0$ till $t=T$ (e.g. $a=1/10,000$, $T=10$ minutes) afterwards falling to 0 again.

Then if x be the gas concentration inside the room, during the attack $\frac{dx}{dt} = k(a-x)$. Hence $x = a(1 - e^{-kt})$.

Thus at the end of time T , the concentration is $a(1 - e^{-kT})$. If kT is small (e.g. $\frac{1}{15}$, $x = akT$ approximately. After this the gas concentration in the room falls,

and $\frac{dx}{dt} = -kx$, so

$$x = a(1 - e^{-kT})e^{k(T-t)},$$

or $a(e^{kT} - 1)e^{-kt}$. Thus the gas concentration will only fall to half its maximum value after a further time of $\frac{\log_e 2}{k}$ hours.

Since the killing power of the gas is roughly proportional to its concentration integrated with regard to time (i.e. multiplied by the time if the concentration is constant), it is worth while calculating this.

During the duration T of the gas attack,

$$\begin{aligned}\int_0^T x dt &= \int_0^T a(1 - e^{-kt}) dt \\ &= a \left(T + \frac{e^{-kT} - 1}{k} \right)\end{aligned}$$

or if kT is small, approximately $2akT^2$. Thus it increases with the square of the time of exposure. On the other hand it must be remembered that a wind, which lowers T , increases k . After time T ,

$$\begin{aligned}\int_T^\infty x dt &= \int_T^\infty a(e^{kT} - 1)e^{-kt} dt \\ &= \frac{a(1 - e^{-kT})}{k} \\ &= aT - \frac{1}{2}kT^2 \text{ approximately.}\end{aligned}$$

Thus $\int_0^\infty x dt = aT$ for all values of k , and we get the

paradoxical (and untrue) result that the gas-proof room gives no protection. The fallacy arises from neglecting the gradual absorption of gas by breathing (for the same gas cannot poison you twice) and its slow interaction with solid surfaces. It does however bring out the fact that at least a large part of the danger from gas occurs after the external air is clear.

APPENDIX IV

GAS-PROOF BOXES

ON NO HYGIENIC subject is more nonsense talked than on fresh air. This is probably one reason why people take the danger of suffocation in a gas-proof room seriously, and why, until the idea was put to me by Dr. Crowden, the obvious suggestion did not occur to me that babies and young children should be shut up in airtight boxes during a gas attack.

It is surprising how long it takes to render the air in such a box foul enough to cause any danger or serious discomfort. Let us take some actual figures. An airtight box 3 ft. x 3 ft. x 4 ft. holds 36 cubic feet. A baby 5½ months old and weighing 22 lbs. produced about 0.54 cubic feet of CO₂ per hour during a restless day, and used about 0.64 cubic feet of oxygen. That is to say if the baby is shut up in the box for an hour the carbon dioxide rises from 0.0 per cent to 1.5 per cent, and the oxygen falls from 20.9 per cent to 19.1 per cent. In neither case is the change perceptible. That is to say if one had to breathe alternately out of two bags, one containing ordinary air, and the other containing air vitiated to the above extent by breathing, but cool, one would be unable to tell the difference between them. The air is exhausted at about the same rate by an adult at rest or a four-year old child which is moderately quiet. With complete rest the rates are considerably lower.

In order to demonstrate this fact, and still more to see how children and mothers behaved under these circumstances, I had a tank made of 14 gauge galvanized electrically welded mild steel. The tank is 3 ft. square and 4 ft. deep. Round the top is an iron channel. The square lid has a flange which fits into this channel. The lid is of the same material, but the central part of it consists of a 2 ft square of $\frac{1}{16}$ inch plate glass in a square angle iron frame to which it is fixed with putty. When the tank is in use water is poured into the channel round the top so as to form an airtight seal. For this purpose the tank must be kept exactly level. The lid and the tank are both fitted with lifting handles, and the whole thing weighs $2\frac{1}{4}$ cwt. This is somewhat too large. A smaller size is suggested later.

Mrs. A, Mrs. B, and Mrs. C are mothers of young children. When it was suggested to Mrs. A that I might borrow her baby she became extremely indignant at the suggestion. I do not know whether she would have been equally angry had someone suggested that she might support the present Government which is not supplying her baby with protection, whereas I proposed to do so. Mrs. B has a little girl two years old. She was persuaded to go into the box, but soon began crying. Her mother then got me to remove her. She took the view that it might be possible gradually to accustom her daughter to staying in this box, but that if she were not taken out it would cause a psychological trauma. This is almost certainly true; but it is nothing to the psychological trauma which would be caused to the mother if she watched her daughter being poisoned with chloropicrin vapour

because the windows of the family refuge-room had been broken by high explosive bombs, and during the subsequent gas attack respirators were available for adults only. Actually in such a case the mother would very possibly tear off her own respirator and die with her child.

Mrs. C has a baby six months old. She is a "tougher" person than Mrs. A and Mrs. B and her opinions are more to the left. However, in order to reassure her I sat in the box myself and read a book for an hour. I got rather hot, and towards the end of the hour I think I was breathing a little more deeply owing to the carbon dioxide which I had produced. However, I could have stayed for two hours without harm. Since I had not exhausted 36 cubic feet in one hour, it will be clear that the official provision of 150 cubic feet per hour in a shelter (see p. 167) is excessive as regards oxygen supply. It is not excessive for cooling a large cellar. But it is excessive for cooling a tunnel, where the walls would have a large cooling effect.

Mrs. C admitted that her baby did not produce as much heat or carbon dioxide as myself and was therefore willing to put it in the tank. So some blankets and cushions were put on the floor, and the baby deposited there. I could not persuade her that the baby would be happier naked; and as it was summer, and the baby was wearing a woollen garment, he got rather warm. He also started crying after a while, possibly because he had dropped a toy. However, Mrs. C stuck it out for half an hour, and the baby was then taken out, undamaged.

This tank is quite unnecessarily large for a baby. It

was intended to hold a possibly fractious child up to four years old. The glass was placed at the top because such a child would be more likely to break a window at the side, or to push on it so that it ceased to be airtight. For a baby a box 3 ft. square and 2 ft. high would suffice for somewhat over an hour. For an older child, it would be better to have it 4 ft. long by 2 ft. wide, and 4 ft. high. This could be got through a door more easily. And the main part of the tank, though not the lid, should be made of lighter metal. If the child can be persuaded to keep still, a smaller tank will do, and the window can be in the side, not the top.

I believe that, even during a dead calm, the danger of non-persistent gas would rarely, if ever, last for an hour during an air raid. And a few minutes' exposure to mustard gas (in the vapour form) will not endanger life. So in this case evacuation to a gas-free area is the best measure. Hence tanks or boxes of this kind will save the lives of children so far as the danger from gas is concerned.

Nevertheless I hesitate to recommend people to buy them, because I think the danger from gas is unimportant compared with that from high explosives. They will do better to spend the money on postcards to M.P.s. My tank was made in a hurry, and cost me £6 5s. I shall be glad to resell it for that price if any mother wants it. The price would be far less if they were made in bulk.

To me the greatest interest of this experiment was not in the fact that one can live for a long time in such a box or tank, which I knew already, but in the reaction

of the mothers and children. If our babies are to be put in gas-proof bags, both they and their mothers will have to be trained in their use. And this will be no light task for the air wardens. However, if we ever have an adequate bomb-proof and gas-proof shelter system on the lines of Chapter VIII, individual protection for babies will no longer be needed.

BIBLIOGRAPHY

Air Defence and the Civil Population, H. Montgomery Hyde and G. R. Falkiner Nuttall; Cresset Press, London, 1937.

Air War, W. O'd Pierce; Watts, London, 1937.

Board of Education Circular 1461, 1938; "Air Raid Precautions in Schools."

Cement and Concrete Association Leaflets:

No. 1 "Air Raid Shelters."

No. 2 "Splinter-proof Shelters for Factories and Large Buildings."

No. 3 "Splinter-proof Shelters for Private Houses and Small Buildings."

"Air-Raid Protection."

"Air-Raid Shelters in the Home."

Despatch from the first British delegate to the International Commission for the Revision of the Rules of Warfare, The Hague, Dec. 10, 1922-Feb. 17, 1923. Government White Paper, Miscellaneous No. 14 (1924).

"Fact," No. 13, *Air Raid Protection: The Facts*, by 10 Cambridge Scientists, London, 1938.

Journal of the Institution of Civil Engineers, 1937, vol 5, pp. 463-566.

League of Nations Official Documents, No. C. 201. M. 126. No. A. 16. 1925. I.

- Medical History of the War*, Vol. 2.
On Guard against Gas, H. Sisson, Hutchinson, London, 1938.
Préparons la défense anti-aérienne, General Niessel, Paris.
Protection of the Public from Aerial Attack, Gollancz, London, 1937.
Protection of Civil Populations in Case of Air Raids, London Trades Council, February 1938.
Records of London Wells, Geological Survey Memoir, 1913.
Report on the Ventilation of Factories and Workshops, 1902. Parliamentary Paper Cd. 1302.
The Crime on the Road Malaga-Almeria, Publicaciones Iberia.
Ueber der Luftwechsel in Wohngebäuden, Pettenkofer; Munich, 1858.

HOME OFFICE

Circulars.

No. 700,216/14	9.7.35	Air Raid Precautions.
No. 701,074/5	28.1.38	Air Raid Precautions Act, 1937.
No. 701,500/55	10.12.37	First Aid Posts.
No. 701,513/8	26.4.38	First Aid Posts.
No. 701,582/10	23.2.37	Air Raid Precautions. Badges for Volunteers.
No. 701,255/3	27.2.37	Air Raid Precautions. (Role of the police, etc.)
No. 701,092/14	31.5.37	(Local authorities and industrial premises.)
No. 751,865/1	23.2.37	(Fire brigades.)
No. 751,866/7	15.12.37	" "
No. 701,262/8	4.5.38	Air Raid Warning Signals.

- | | | |
|-----------------|----------|---|
| No. 700,225/114 | 14.2.38 | Lighting Restrictions. |
| No. 701,562/22 | 8.7.37 | Anti-Gas Training. |
| No. 701,529/42 | 10.7.37 | Anti-Gas Training. |
| No. 701,527/34 | 7.2.38 | Civilian Anti-Gas Schools. |
| No. 701,529/22 | 31.8.36 | Anti-Gas Training. |
| No. 701,520/33 | 17.12.36 | Anti-Gas Training, Gas
Vans and Gas Cham-
bers. |
| No. 701,621/47 | 16.12.36 | Anti-Gas Training.
Scheme of Medical
Instruction. |
| No. 701,602/109 | 31.12.37 | Experiments in Anti-Gas
Protection of Houses. |

Memoranda.

- | | | |
|-------|------|---|
| No. 1 | 1937 | Organization of Air Raid Casu-
alties Services. |
| No. 2 | 1937 | Rescue Parties and Clearance
of Debris. |
| No. 3 | 1938 | Organization of Decontamination
Services. |
| No. 4 | 1937 | Air Raid Wardens. |
| No. 5 | 1937 | Anti-Gas Training. |
| No. 6 | 1938 | Local Communications and
Reporting of Air Raid Dam-
age. |
| No. 7 | 1938 | Personnel Requirements for Air
Raid General and Fire Pre-
cautions Services, and the
Police Service. |

Handbooks.

No. 1	1937	Personal Protection Against Gas.
No. 2	1938 (2nd. ed.)	First Aid for Gas Casualties.
No. 3	1937	Medical Treatment for Gas Casualties.
No. 4	1937	Decontamination of Materials.
No. 5	To be published	Structural Precautions Against Bombs and Gas.
No. 6	1937	Air Raid Precautions in Factories and Business Premises.
No. 7	1937	Anti-Gas Precautions for Merchant Shipping.

Statutory Rules and Orders.

No. 251	1938	Air-Raid Precautions.
No. 252	1938	Air-Raid Precautions, England, Fire Schemes.
No. 253	1938	Air-Raid Precautions, London.

Other Publications.

Air-Raid Precautions Act, 1937.

Air-Raid Precautions Act, 1937, Air Raid General Precautions Scheme.

Air-Raid Precautions Act, 1937, Summary of Provisions.

The Protection of Your Home Against Air Raids.

Memorandum on Emergency Fire Brigade Organization.

An Atlas of Gas Poisoning.

Sketch of Emergency Fire Brigade Organization for
a Hypothetical Town.

The Protection of Footstuffs Against Poison Gas.

Certification Mark for Respirators Giving Protection
Against Poison Gases Used in War.

Certification Mark for Filtration Plants Giving Pro-
tection Against Poison Gases Used in War.

APPENDIX V

RECENT DEVELOPMENTS

SINCE I WROTE this book Mr. Sandys, M.P. has been threatened with a court-martial for attempting to disclose our lack of anti-aircraft guns, and Lieut.-Colonel Cawston, the A.R.P. officer for Chatham, has been induced to resign for advocating tunnels in the chalk as shelters. Some very important documents have appeared. The Architects' Journal (price 6d.) has published accounts of the damage to Barcelona, by Mr. F. Skinner, on June 16th and 23rd. These usually confirm my Chapters I and II. Where we differ, I have little doubt that Mr. Skinner's opinion is generally to be preferred, if only because he was in Barcelona later than I. On the whole I have overestimated the damage done by bombs.

So, if Mr. Skinner is correct, has Mr. Sandys, M.P. Mr. Skinner attributes the damage described on pp. 54 and 55 to several bombs bursting at once. On the other hand he states that people were killed at 200 yards from a bomb by blast alone.

The same Journal for July 7th contains the report of the A.A.S.T.A. (Association of Architects, Surveyors and Technical Assistants) Committee, under the chairmanship of Mr. J. Pinckheard. This is in my opinion the most important document on A.R.P. yet published, and every municipal councillor should buy a copy.

The cost per head of a system of tunnels works out at £10 19s. 0d. per head. Their scheme differs from my own in four respects. The tunnels are at 50, not 60, feet depth. They are lined with "Locksheet" steel, not brick. They are 6½ ft. wide, 7½ ft. high, and arched with vertical walls. The entrances are by staircases with occasional landings, and numerous turns, the average slope being about 1 in 3. The staircases are 5½ ft. wide with a central handrail. One staircase is provided per 500 people, whereas I have suggested one ramp per 1,000.

It is probable that steel tunnels are to be preferred to brick. On the other hand a tunnel with vertical walls is more likely to be blown in by shock propagated sideways through the earth than one with a circular section. For this reason I think that such tunnels should be at a depth of 60 or 70 feet, which would probably bring the cost per head up to about £12. The question of stairs versus ramps merits further consideration. It may be thought that in a panic rush people are rather more likely to be crushed on a ramp than on a stair. On the other hand the number of stairs in the A.A.S.T.A. plan is double my number of ramps. Hence the refugees would not have to go so far from their houses, on an average, to find the entrance to the nearest shelter.

In the discussion which the A.A.S.T.A. report is arousing in professional circles a very important suggestion has been made. It is thought that it might be cheaper to build tunnels of large section like those of the London Tube Railways, and furnished with several floors, so that the number of people seated

per linear yard would be very much increased. These tunnels would have the very great merit that at a later time when the danger of war is less imminent they could be adapted as underground roads or railways. If this is correct the objections to such a scheme given on pp. 219 and 220 are, of course, invalid.

I understand that the cost of tunnelling in waterlogged soil is uniformly about 50% more than in dry soil. Thus even in waterlogged soil tunnels are probably cheaper than cellular shelters. The cost and feasibility of tunnelling in rock varies locally. It is up to public-spirited men and women to investigate this in their own locality.

Mr. John Langdon-Davies has published a book called *Air Raid*,¹ describing the attacks on Barcelona on March 18th to 20th (see p. 54). I can strongly recommend it, not only for its admirable descriptive writing, but for its magnificent photographs. Nevertheless I cannot endorse all the author's statements. Neither he nor I was in Barcelona during the raids described. And although he has been there since and I have not, yet I have interviewed a number of people who were present during them, and have the benefit of Mr. Skinner's description both of the effects of the raids, and of the shelters in the town. It must be remembered that Mr. Skinner is a qualified architect, and went to Barcelona specifically to investigate these points.

Let us take a few examples where Mr. Langdon-Davies' statements diverge from my own. He says there were about 3,000 killed (his p. 14). Mr. Skinner

¹Routledge, 2/6.

gives the number at 912; I gave it at about 1,300 (my p. 54). Here no definite decision is possible. Mr. Langdon-Davies states (his p. 120) that there are eight or ten large bomb-proof shelters capable of housing about 8,000 people, and 1,200 private shelters, motly cellars with strengthened roofs. These are open to the public. "There are also in the suburbs caves and tunnels dug out of hillsides which offer permanent safety with a minimum of comfort to a few hundred families who have become cave-dwellers for the duration." On p. 21 he estimates that 15,000 can get to absolutely safe shelter, and 50,000 more to reasonably safe shelter.

Mr. Skinner's figures¹ for the capacity of the shelters are:

Reinforced concrete shelters	.	20,000
Shelters under buildings	.	13,000
Small straight tunnels	.	15,000
Large ,, ,,	.	27,000
Systems of branched tunnels	.	242,000
Total		317,000

I take it that Mr. Skinner's figures date from May 1938. I think that a professional architect is unlikely to make very large mistakes, and although a good deal of extra shelter was doubtless provided between March and May, I cannot believe that it is responsible for the very great difference in the figures. It is, however, true that most of the tunnels which I saw were in the suburbs, and not in central Barcelona. It is

¹ Architect's Journal 87, p. 1060, June 23rd, 1938.

also true, as Mr. Skinner says, that, owing to the fact that there are "only enough shelters for about one seventh of the present population of Barcelona, the authorities do not advertise the presence of shelters unduly for fear of overcrowding." These facts may account for what I believe to be Mr. Langdon-Davies' serious underestimate. But Mr. Skinner and I may have been deceived.

Again I think Mr. Langdon-Davies overestimates the psychological effect of the raids. According to my information the majority of the people of Barcelona remained fairly calm, though work was stopped in most factories. And so far were the people from being completely demoralized, that within a few days a mass demonstration whose number has been estimated at half a million marched through the streets demanding the continuation of the war.

I also think that he has fallen for the fallacy of dispersal. He says (p. 46) that "the Metros are not safe from bombs; people would have been safer in their homes." This is untrue. A direct hit by a single bomb on a crowded tunnel too near ground level would kill hundreds. But the chance of such a hit is fairly small. And in their houses people are killed when they collapse as the result of explosions some distance off. Thus each individual is in more danger at home than in the Metro, just as a chance of one in a hundred of winning one pound is better than a chance of one in a million of winning a thousand pounds. And in a long series of raids the casualties will be greater if people stay at home.

These, however, are minor points. Mr. Langdon-

Davies' main theme is what he calls "The Technique of Silent Approach" (see my p. 51). The bombers shut off their engines many miles out at sea, glide downwards at a gentle slope, drop their bombs before they are detected, and are actually on their way home when the bombs fall. Hence the sirens which give warning of air raids are worse than useless. They merely frighten people after the danger is past. The anti-aircraft barrage is started too late. Its noise adds to the panic. Its shrapnel kills a few people in the streets. Even if the bombers are detected a few seconds before they drop their bombs, people have no time to seek shelter. Shelters are therefore useless unless one remains underground during most of a series of raids.

Further, this technique is said to be applicable to Britain. "At the beginning of any war, raids carried out according to the Technique of Silent Approach are likely to be the normal experience of London. Air-raid shelters will, therefore, be of little use unless people can stay in them for an unlimited number of hours, and even days" (his p. 123).

I disbelieve his forecast for the following reasons. Mr. Langdon-Davies states (his pp. 38, 39) that in 1918 the best gliding angle was about 1 in 20, and that since then "great progress has been made," so that a medium-weight bomber might glide at 120 m.p.h. at an angle of 1 in 30. It is true that the air resistance of 'planes has been greatly diminished. And good gliders can avoid stalling at an angle of descent of about 1 in 30. But a fast bomber, just because it goes fast, has less wing area per unit weight than the machines of 1918. Hence it must go fast to keep in the air at all.

And it drops fairly steeply when not going fast. I doubt if any existing bomber when fully loaded can glide at a gentler slope than 1 in 15, and whether many can achieve even this.

Mr. Langdon-Davies regards the March raids on Barcelona as a dress rehearsal for an attack on London (his p. 14). Now Barcelona lies on the coast. It may be that the Spanish sound detectors can detect bombers as far as 25 miles out to sea. I very much doubt whether they can do so beyond 15 miles on most days. This means that a 'plane shutting off its engines 20 or 25 miles from the coast and then gliding at 1 in 15 drops between 1 and 2 miles during its glide. Now in the case of London, if bombers are not to be detected by sound they must shut off their engines some 15 miles east of Shoeburyness, and glide for 50 miles to reach Central London. This means a drop of about 3 miles. If they are to get over a balloon barrage 10,000 feet high they must therefore shut off their engines at 25,000 feet up. Such a climb is practicable, but means a reduction in their load of bombs. Actually we may assume that the air defence would include listeners on ships in the Thames estuary outside Shoeburyness, and the glide would have to be longer still.

It must also be remembered that a glide is not completely noiseless; and it is at least possible, as Mr. Langdon-Davies suggests (his p. 37) that the electromagnetic field set up by the engines of aeroplanes can be detected at a greater distance than 25 miles, which is about the limit for sound detection.

But the real point, which Mr. Langdon-Davies completely misses, is this. A gliding aeroplane is

extremely vulnerable both by fighters and anti-aircraft artillery if it is once detected. It is moving slowly, and it cannot manœuvre until it has gained speed. And it takes some time to gain full speed, as the engines are cool. In March 1938 there were very few fighting aeroplanes in the neighbourhood of Barcelona. One object of the attacks was to draw them away from the Aragon front, which was attacked on March 9th. And a good number were so withdrawn.

Mr. Langdon-Davies appears to think (his p. 15) "that had the technique been used for another 48 hours there would have been a total paralysis of the life of the city and of the power to resist. Indeed it is something of a mystery why the raids were broken off when their continuance could have achieved so much." He suggests that they were terminated either for diplomatic reasons, or because their continuance would have taught the English and French too much. I think the former motive may be doubted. If another 48 hours of bombing would have won the war, it might have created some protest in England, but less than the subsequent sinking of British ships. I believe that the raids were stopped partly because they had only created a partial and not a general panic, and partly because enough fighters were available to make their continuance dangerous.

Later events seem to confirm this view. Castellon is a port like Barcelona. If bombs could have been dropped on it without warning its shelters would have been useless. The warning given was short. But unless Mr. Forrest is a very complete liar, it was effective (my pp. 170-172). The Technique of Silent

Approach was no longer a secret in May. It would have been applied had it been applicable. Even if the bombers came from Spain, not from Majorca, they could have flown out to sea at Vinaroz, and approached Castellon from the sea.

Unless we accept the view that the Technique of Silent Approach could not be applied to Castellon for military reasons we are forced to the alternative that Hitler and Mussolini are in no hurry to win the Spanish war, but are simply using Spain as a means to test various military techniques. I confess that I cannot bring myself to believe this.

If there was even a slight danger to a squadron of bombers attempting to glide on Castellon, there would obviously be a far greater danger in a similar attack on the British coast. For even now one sees far more aeroplanes in England than in loyal Spain, and a continuous patrol by fighting 'planes would be perfectly practicable in England in wartime, whereas it is not so in Spain.

To sum up, it would seem that the Technique of Silent Approach is unlikely to be a serious menace to London, and will probably not be so even to the north-eastern coast towns. However, I recognize that the answer depends on technical developments both in the air and as regards detection which are at least partly secret. It seems urgent that Members of Parliament who take the lives of their constituents seriously should ask how far the official statements regarding a warning period of 7 to 10 minutes have to be modified in view of Mr. Langdon-Davies' arguments. And if they are told that these times still hold

good they should certainly not accept my arguments if they can obtain technical information from the Government. Unfortunately this is very difficult to do.

Mr. Langdon-Davies comes to some conclusions with which I strongly dissent. "The Defence's primary duty, therefore, is to guard against panic, and reduction of casualties is a secondary consideration" (his p. 122). He supports a programme of summer camps (see my Chapter VII) but apparently without shelters. Underground tunnels are to be made in London, but primarily for traffic, although I believe that in practice they would be blocked with refugees during a series of raids.

He lays great stress on the psychological value of work during air raids. "Anything that will help people to feel that they are still of use, that is, that others need them, has a steadying effect" (his p. 109). "Everybody should have his appointed task in an air raid, and the task should not be one normal to their everyday life, unless the normal task is essential" (his p. 110). Some should start rolling bandages, others preparing food for rescue squads, and so on. This seems to agree with the Government policy of appointing hundreds of thousands of Air Raid Wardens and other officials, while doing nothing to protect them. It is, in fact, the opposite of the policy of my book.

There can be no doubt that this part of Mr. Langdon-Davies' policy will be eagerly seized upon by Government apologists. Indeed it is very significant that he has been permitted to broadcast, while there has been no description on the radio of the vast system of underground shelters which exists in Spain. I agree with

him that "a realization that the ability to take part in communal life has vanished" is very demoralizing. It is so to many of the unemployed in peace time. But if we cannot organize work for all in peace, I do not think that we shall be able to do so in war. And I think most people would soon discover that the tasks set them were of little practical use. I further question the psychological value of work. During a raid in May "The people who were working bore up better than the ones who were waiting, but I had the impression that 'business as usual' was an antidote for fear for at best a very short time" (his p. 108). These people were working above ground. I prefer 60 feet of earth to any amount of work as an antidote to fear.

Nevertheless I agree with a number of Mr. Langdon-Davies' points. He stresses the importance of evacuation, though he is unduly vague as to its details, which are all-important. On the other hand in my Chapter VIII I have perhaps not sufficiently emphasized the importance of preliminary propaganda to ensure that evacuation is voluntary and rapid. He points out that during a period of air raids workers may be unable to go to and from their work daily, and must have shelters at their place of work. He points to the bad effect of noise and the value of ear defenders. He states that people should be taught to distinguish between the sound of bombs and that of anti-aircraft guns, since the latter, which should be reassuring, is actually alarming.

But if the two-year plan of Chapter VIII is carried out, many of these problems will not arise. The people will get the habit of going underground during a raid

without panic, they will be underground before the noise begins, and they will be willing to come up again at once when the "All Clear" sounds. I do not claim Mr. Langdon-Davies' knowledge of psychology. But I know that panic rarely develops during the first of a series of raids. If there is adequate protection for life it need never develop at all. It has been the whole purpose of this book to show that adequate protection is possible, and to do all that lies within my power to ensure that the People shall demand it and obtain it.

I have discussed the questions raised in this Appendix with Mr. Langdon-Davies, and we have concluded that our points of agreement are much more numerous than our differences. We realize that the opponents of full protection, whether supporters of the Government or absolute pacifists, will attempt to make capital out of our divergences. We therefore propose to issue a joint memorandum emphasizing the points upon which we agree, and dealing with new aspects of the problem which have arisen from our discussion. This memorandum will be published in the *Left News* simultaneously with the publication of this book.

July 20th, 1938.

INDEX

- Abyssinia, 18, 21, 44, 66, 236, 260
 acetyl-choline, 112
 Adamsite, 256
 Air Raid Precautions Act, 85, 229
 Air Raid Wardens, 127, 202, 204, 241
 Anderson, Sir John, 186, 195
 anti-aircraft guns, 17, 71, 77, 217, 282
 armour-piercing bombs, 28, 211
 Association of Architects, Surveyors and Technical Assistants, 168, 282
 babies, gas protection for, 98, 203, 267, 273
 bacteria, 37
 Baldwin, Earl, 231, 247
 balloon barrages, 70, 217
 Barcelona, 23, 26, 40, 51, 52, 71, 75, 117, 164, 174, 180, 199, 283
 Bilbao, 50
 Blackburn, 102
 black-outs, 66, 68, 81, 137
 blast, 31, 118, 121, 144, 149, 159, 211
 Board of Education, 107, 124
 bureaucracy, 131, 222
 Butler, 66
 Cambridge Scientists, 88, 101, 195, 266
 Campbell, Sir Malcolm, 178
 camp schools, 196, 216
 Carrier Engineering Co., 167
 Castellon, 170
 Catholic Church, 50, 56
 cellars and strong-rooms, 48, 149, 206
 Cement and Concrete Association, 238
 Chamberlain, 53
 China, 27, 57, 66
 Churchill, Mr. Winston, 192
 combined attacks, 36
 concrete shelters, 174, 176, 215, 239, 283
 cost of shelters, 166, 229
 decontamination, 107, 131
 Derby, 65
 diphenyl-arsine-cyanide, 101, 256
 dispersal, 124
 Duff-Cooper, 79
 dug-outs, 57, 150, 157
 Durango, 49
 Eden, 127
 Edinburgh, 2, 33, 68, 214
 evacuation, 17, 78, 136, 182, 208, 216
 explosions, 28
 factories, 120
 Fascism, 230
 ferro-concrete buildings, 33, 35, 144
 filters, 167, 214
 fire brigades, 115, 204
 fire protection, 113
 flooding, 162, 217
 food storage, 140, 209, 218
 fragmentation bomb, 28
 France, 44, 102, 206
 France, 24, 234
 gas, 20, 23, 44, 87, 203, 224, 254, 263, 268, 272. See also *respirators, gas-proof rooms, Abyssinia, combined attacks*
 gas-proof rooms, 87, 106, 124
 Germany, 41, 62, 75, 90, 173, 181, 188, 206, 210, 230

- Gibraltar, 230, 243
 Goering, 50, 192, 196
 Great War, 17, 19, 22, 23, 33, 37,
 40, 48, 53, 63, 69, 73, 82, 111,
 158, 227, 260
 Guernica, 27, 49, 149

 Hague Convention, 58
 Haldane, J. S., 8, 90
 Haldane, Lord, 235, 242
 Halsbury, Lord, 21
 Hamburg disaster, 21
 Harlech, Lord, 43
 high explosives, 27, 29, 117, 142
 Hitler, 62, 232
 Hodsall, Wing-Commander, 99
 Hoare, Sir Samuel, 81, 86, 87,
 125, 134, 179, 185, 194, 206,
 210, 222, 235, 240
 Hore-Belisha, 72
 hospitals, 133, 217, 224
 Hull, 68, 156, 191, 214

 incendiary bombs, 16, 25, 36,
 48, 113, 114
 India, 42, 60, 226, 233
 international law, 50, 58, 218, 250
 Irak, 43
 Italy, 75, 173, 230

 Japan, 27, 43, 58

 Kellogg Pact, 60

 Labour Party, 11, 240, 246
 League of Nations, 44, 45, 61,
 180, 235
 lighting restrictions, 81, 203
 Lloyd, Mr. Geoffrey, 89, 186, 191,
 196, 205
 London, 17, 33, 37, 54, 62, 63,
 68, 70, 113, 154, 156, 159,
 160, 186, 188, 191, 194, 212,
 214, 219
 Londonderry, Lord, 44, 60, 231

 machine-guns, 16, 37, 68
 Madrid, 25, 47, 69, 71, 75, 86,
 116, 142, 158, 160, 184
 Majorca, 51

 Malaga, 37
 Marshall, 110
 medical services, 132
 Mussolini, 62, 232
 mustard gas, 18, 25, 39, 44, 94,
 97, 108, 110, 204, 255, 260,
 264

 Nanking, 58
 Negrin, 180
 Newcastle, 163
 Niessel, General, 44
 non-persistent gases, 18, 255

 pacifism, 84, 244
 panic, 37, 42, 55
 Paris, 37, 168, 180
 penetration, 35
 persistent gases, 18, 255
 Pettenkofer, 90
 phosgene, 18, 20, 93, 255, 264,
 266
 phosphorus bombs, 25, 114
 Piccadilly Circus Station, 36, 161
 Pierce, 48
 Pinckheard, 168, 282
 "police bombing", 42, 233

 R.A.F., 42, 77, 232
 refuge-rooms, 118, 144
 rescue parties, 130
 respirators, 24, 39, 98, 100, 203,
 214, 260, 263
 road attacks, 16, 80, 143, 192

 Sagunto, 26, 56, 74
 Sandys, 54, 288
 school children, 107, 124, 189,
 194, 208, 216
 Scott, 147
 searchlights, 72
 Shanghai, 145
 Sheffield, 62, 191
 shipping, 139, 217, 230
 shock, 34, 173, 211
 Silent approach, 51, 283
 Simon, Sir John, 235
 Sisson, 93
 Skinner, 164

- Spain, 23, 24, 27, 33, 34, 36, 47,
64, 66, 75, 80, 113, 138, 150,
157, 199, 217, 236. See also
Barcelona, Madrid, etc.
- splinters, 30, 118, 147
- St. Pancras, 163
- Sweden, 72
- smoke, 19, 101, 256, 266
- thermite, 25, 27, 114
- Tortosa, 54, 56, 185
- towers, 181
- Trade Unions, 165, 219, 240
- trenches, 119, 150, 204, 210
- trinitrotoluene, 30, 38
- tunnels, 164, 211, 219, 236, 283
- underground railways, 48, 160,
168, 207
- University College, 149
- U.S.A., 27
- U.S.S.R., 27, 223, 233
- Valencia, 26, 66, 71, 177, 236
- Watson, 166
- West Middlesex Main Drainage,
166

